

(12) **United States Patent**  
**Gass et al.**

(10) **Patent No.:** **US 7,024,975 B2**  
(45) **Date of Patent:** **Apr. 11, 2006**

(54) **BRAKE MECHANISM FOR POWER EQUIPMENT**

(75) Inventors: **Stephen F. Gass**, Wilsonville, OR (US); **Joel F. Jensen**, Redwood City, CA (US); **Anwyl M. McDonald**, Palo Alto, CA (US); **David S. D'Ascenzo**, Portland, OR (US); **Andrew L. Johnston**, Redwood City, CA (US)

(73) Assignee: **SD3, LLC**, Wilsonville, OR (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 293 days.

(21) Appl. No.: **09/929,241**

(22) Filed: **Aug. 13, 2001**

(65) **Prior Publication Data**

US 2002/0017180 A1 Feb. 14, 2002

**Related U.S. Application Data**

(60) Provisional application No. 60/225,056, filed on Aug. 14, 2000, provisional application No. 60/225,057, filed on Aug. 14, 2000, provisional application No. 60/225,058, filed on Aug. 14, 2000, provisional application No. 60/225,059, filed on Aug. 14, 2000, provisional application No. 60/225,089, filed on Aug. 14, 2000, provisional application No. 60/225,094, filed on Aug. 14, 2000, provisional application No. 60/225,169, filed on Aug. 14, 2000, provisional application No. 60/225,170, filed on Aug. 14, 2000, provisional application No. 60/225,200, filed on Aug. 14, 2000, provisional application No. 60/225,201, filed on Aug. 14, 2000, provisional application No. 60/225,206, filed on Aug. 14, 2000, provisional application No. 60/225,210, filed on Aug. 14, 2000, provisional application No. 60/225,211, filed on Aug. 14, 2000, provisional application No. 60/225,212, filed on Aug. 14, 2000.

(51) **Int. Cl.**  
**B27B 5/29** (2006.01)  
**B23D 45/04** (2006.01)

(52) **U.S. Cl.** ..... **83/62.1**; 83/477.2; 83/490; 83/DIG. 1

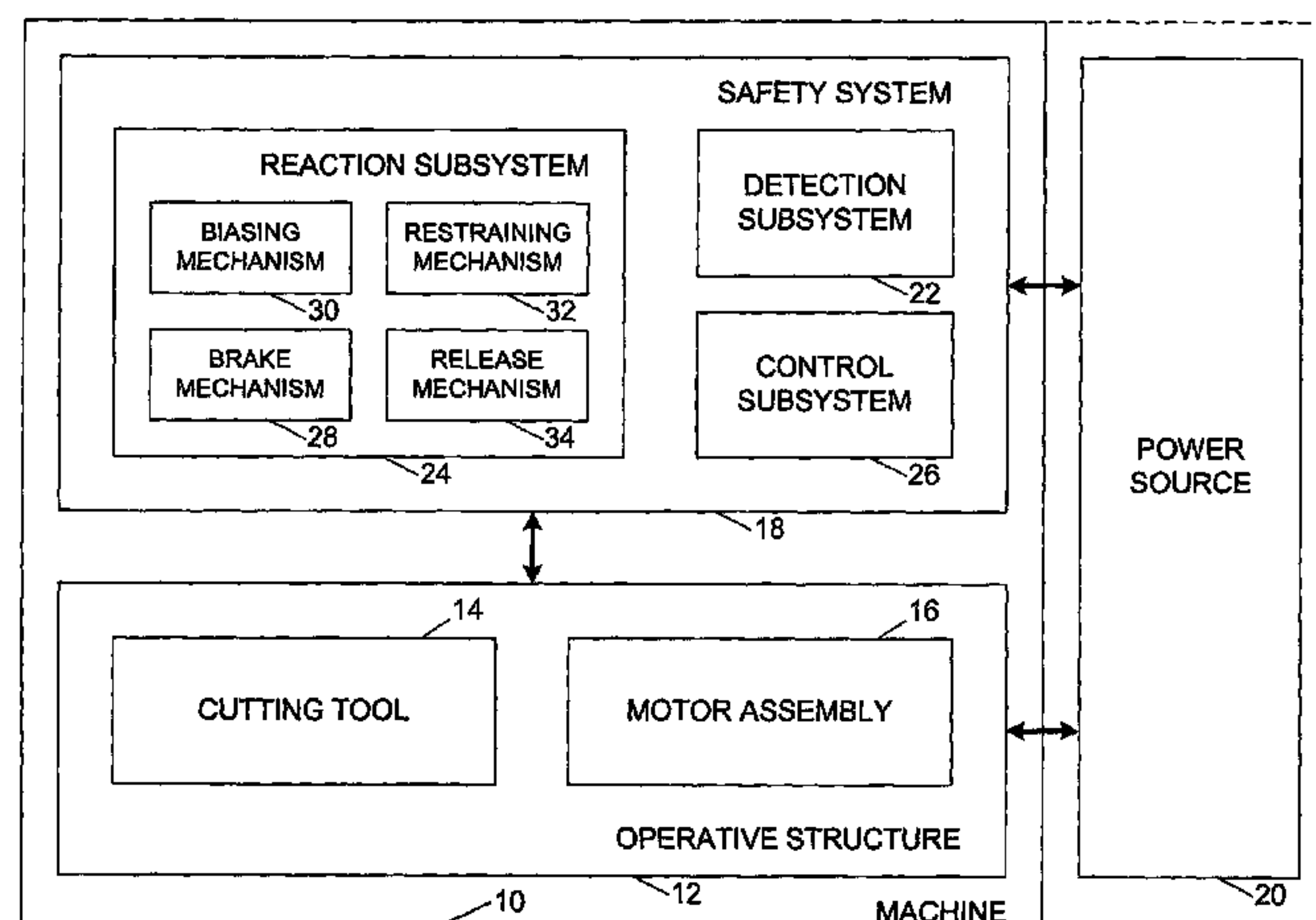
(58) **Field of Classification Search** ..... 188/82.7, 188/82.74, 82.77, 82.9, 371, 376, 377; 56/10.4, 56/11.3; 307/142, 115, 639, 328, 320, 116, 307/131; 83/DIG. 1, 544, 397, 477.1, 473, 83/471.3, 478, 397.1, 61, 62.1, 63, 46, 72, 83/75, 76.7, 76.8, 76.9, 359, 368, 370, 371, 83/58, 491, 526, 471.2, 485, 522.12, 487, 83/546, 581, 590, 665, 490, 477.2, 357, 398, 83/471, 501, 932; 403/2; 44/390, 2, 35; 144/384, 391, 427, 154.5, 356; 192/124 R, 192/133, 148, 144, 142 R, 138, 137; 340/280; 30/387, 381; 292/290, DIG. 66; 411/390, 411/2, 29

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

146,886 A	1/1874	Doane et al.
162,814 A	5/1875	Graves et al.
261,090 A	7/1882	Grill
264,412 A	9/1882	Kuhlmann
299,480 A	5/1884	Kuhlmann et al.
302,041 A	7/1884	Sill
307,112 A	10/1884	Groff
509,253 A	11/1893	Shields
545,504 A	9/1895	Hoover
869,513 A	10/1907	Pfeil
941,726 A	11/1909	Pfalzgraf
997,720 A	7/1911	Troupenat
1,037,843 A	9/1912	Ackley
1,050,649 A	1/1913	Harrold et al.
1,054,558 A	2/1913	Jones
1,074,198 A	9/1913	Phillips
1,082,870 A	12/1913	Humason
1,101,515 A	6/1914	Adam
1,126,970 A	2/1915	Folmer
1,132,129 A	3/1915	Stevens
1,148,169 A	7/1915	Howe
1,154,209 A	9/1915	Rushton
1,205,246 A	11/1916	Mowry



1,228,047 A	5/1917	Reinhold	2,530,290 A	11/1950	Collins
1,240,430 A	9/1917	Erickson	2,554,124 A	5/1951	Salmont
1,244,187 A	10/1917	Frisbie	2,562,396 A	7/1951	Schutz
1,255,886 A	2/1918	Jones	2,572,326 A	10/1951	Evans
1,258,961 A	3/1918	Tattersall	2,590,035 A	3/1952	Pollak
1,311,508 A	7/1919	Harrold	2,593,596 A	4/1952	Olson
1,324,136 A	12/1919	Turner	2,601,878 A	7/1952	Anderson
1,381,612 A	6/1921	Anderson	2,623,555 A	12/1952	Eschenburg
1,397,606 A	11/1921	Smith	2,625,966 A	1/1953	Copp
1,427,005 A	8/1922	McMichael	2,626,639 A	1/1953	Hess
1,430,983 A	10/1922	Granberg	2,661,777 A	12/1953	Hitchcock
1,464,924 A	8/1923	Drummond	2,661,780 A	12/1953	Morgan
1,465,224 A	8/1923	Lantz	2,675,707 A	4/1954	Brown
1,496,212 A	6/1924	French	2,678,071 A	5/1954	Odlum et al.
1,511,797 A	10/1924	Berghold	2,690,084 A	9/1954	Van Dam
1,526,128 A	2/1925	Flohr	2,695,638 A	11/1954	Gaskell
1,527,587 A	2/1925	Hutchinson	2,704,560 A	3/1955	Woessner
1,551,900 A	9/1925	Morrow	2,711,762 A	6/1955	Gaskell
1,553,996 A	9/1925	Federer	2,722,246 A	11/1955	Arnoldy
1,582,483 A	4/1926	Runyan	2,731,049 A	1/1956	Akin
1,590,988 A *	6/1926	Campbell ..... 74/149	2,736,348 A	2/1956	Nelson
1,600,604 A	9/1926	Sorlien	2,737,213 A	3/1956	Richards et al.
1,616,478 A	2/1927	Watson	2,758,615 A	8/1956	Mastriforte
1,640,517 A	8/1927	Procknow	2,785,710 A	3/1957	Mowery, Jr.
1,662,372 A	3/1928	Ward	2,786,496 A	3/1957	Eschenburg
1,701,948 A	2/1929	Crowe	2,810,408 A	10/1957	Boice et al.
1,711,490 A	5/1929	Drummond	2,844,173 A	7/1958	Gaskell
1,712,828 A	5/1929	Klehm	2,850,054 A	9/1958	Eschenburg
1,774,521 A	9/1930	Neighbour	2,852,047 A	9/1958	Odlum et al.
1,807,120 A	5/1931	Lewis	2,873,773 A	2/1959	Gaskell
1,811,066 A	6/1931	Tannewitz	2,883,486 A	4/1959	Mason
1,879,280 A	9/1932	James	2,894,546 A	7/1959	Eschenburg
1,896,924 A	2/1933	Ulrich	2,913,025 A	11/1959	Richards
1,902,270 A	3/1933	Tate	2,913,581 A	11/1959	Simonton et al.
1,904,005 A	4/1933	Masset	2,945,516 A	7/1960	Edgemon, Jr. et al.
1,910,651 A	5/1933	Tautz	2,954,118 A	9/1960	Anderson
1,938,548 A	12/1933	Tautz	2,957,166 A	10/1960	Gluck
1,938,549 A	12/1933	Tautz	2,978,084 A	4/1961	Vilkaitis
1,963,688 A	6/1934	Tautz	2,984,268 A	5/1961	Vuichard
1,988,102 A	1/1935	Woodward	2,991,593 A	7/1961	Cohen
1,993,219 A	3/1935	Merrigan	3,005,477 A	10/1961	Sherwen
2,007,887 A	7/1935	Tautz	3,011,529 A	12/1961	Copp
2,010,851 A	8/1935	Drummond	3,011,610 A	12/1961	Stiebel et al.
2,020,222 A	11/1935	Tautz	3,013,592 A	12/1961	Ambrosio et al.
2,038,810 A	4/1936	Tautz	3,021,881 A	2/1962	Edgemon, Jr. et al.
2,075,282 A	3/1937	Hedgpeth	3,035,995 A	5/1962	Seeley et al.
2,095,330 A	10/1937	Hedgpeth	3,047,116 A	7/1962	Stiebel et al.
2,106,288 A	1/1938	Tautz	3,085,602 A	4/1963	Gaskell
2,121,069 A	6/1938	Collins	3,105,530 A	10/1963	Peterson
2,131,492 A	9/1938	Ocenasek	3,129,731 A	4/1964	Tyrrell
2,106,321 A	10/1938	Guertin	3,163,732 A	12/1964	Abbott
2,163,320 A	6/1939	Hammond	3,184,001 A	5/1965	Reinsch et al.
2,168,282 A	8/1939	Tautz	3,186,256 A	6/1965	Reznick
2,241,556 A	2/1941	MacMillin et al.	3,207,273 A	9/1965	Jurin
2,261,696 A	11/1941	Ocenasek	3,213,731 A	10/1965	Renard
2,265,407 A	12/1941	Tautz	3,224,474 A	12/1965	Bloom
2,286,589 A	6/1942	Tannewitz	3,232,326 A	2/1966	Speer et al.
2,292,872 A	8/1942	Eastman	3,246,205 A	4/1966	Miller
2,299,262 A	10/1942	Uremovich	3,249,134 A	5/1966	Vogl et al.
2,312,118 A	2/1943	Neisewander	3,306,149 A	2/1967	John
2,313,686 A	3/1943	Uremovich	3,313,185 A	4/1967	Drake et al.
2,328,244 A	8/1943	Woodward	3,315,715 A	4/1967	Mytinger
2,352,235 A	6/1944	Tautz	3,323,814 A	6/1967	Phillips
2,377,265 A	3/1945	Rady	3,337,008 A	8/1967	Trachte
2,402,232 A	6/1946	Baker	3,356,111 A	12/1967	Mitchell
2,425,331 A	8/1947	Kramer	3,386,322 A	6/1968	Stone et al.
2,434,174 A	1/1948	Morgan	3,439,183 A	4/1969	Hurst, Jr.
2,452,589 A	11/1948	McWhirter et al.	3,445,835 A	5/1969	Fudaley
2,466,325 A	4/1949	Ocenasek	3,454,286 A	7/1969	Anderson et al.
2,496,613 A	2/1950	Woodward	3,456,696 A	7/1969	Gregory et al.
2,509,813 A	5/1950	Dineen	3,512,440 A	5/1970	Frydmann
2,517,649 A	8/1950	Frechtmann	3,538,964 A	11/1970	Warrick et al.
2,518,684 A	8/1950	Harris	3,540,338 A	11/1970	McEwan et al.



3,554,067 A	1/1971	Scutella	4,321,841 A	3/1982	Felix
3,566,996 A	3/1971	Crossman	4,372,202 A	2/1983	Cameron
3,580,376 A	5/1971	Loshbough	4,391,358 A	7/1983	Haeger
3,581,784 A	6/1971	Warrick	4,418,597 A	12/1983	Krusemark et al.
3,613,748 A	10/1971	De Pue	4,466,233 A	8/1984	Thesman
3,670,788 A	6/1972	Pollak et al.	4,470,046 A	9/1984	Betsill
3,675,444 A	7/1972	Whipple	4,510,489 A	4/1985	Anderson, III et al.
3,680,609 A	8/1972	Menge	4,512,224 A *	4/1985	Terauchi ..... 82/48
3,688,815 A	9/1972	Ridenour	4,518,043 A	5/1985	Anderson et al.
3,695,116 A	10/1972	Baur	4,532,501 A	7/1985	Hoffman
3,696,844 A	10/1972	Bernatschek	4,532,844 A	8/1985	Chang et al.
3,745,546 A	7/1973	Struger et al.	4,557,168 A	12/1985	Tokiwa
3,749,933 A	7/1973	Davidson	4,560,033 A *	12/1985	DeWoody et al. .... 188/2 F
3,754,493 A	8/1973	Niehaus et al.	4,566,512 A	1/1986	Wilson
3,772,590 A	11/1973	Mikulecky et al.	4,573,556 A	3/1986	Andreasson
3,785,230 A	1/1974	Lokey	4,576,073 A	3/1986	Stinson
3,805,639 A	4/1974	Peter	4,589,047 A	5/1986	Gaus et al.
3,805,658 A	4/1974	Scott et al.	4,589,860 A	5/1986	Brandenstein et al.
3,808,932 A	5/1974	Russell	4,599,597 A	7/1986	Rotbart
3,829,850 A	8/1974	Guetersioh	4,599,927 A	7/1986	Eccardt et al.
3,858,095 A	12/1974	Friemann et al.	4,606,251 A	8/1986	Boileau
3,861,016 A	1/1975	Johnson et al.	4,615,247 A	10/1986	Berkeley
3,863,208 A	1/1975	Balban	4,621,300 A	11/1986	Summerer
3,880,032 A	4/1975	Green	4,625,604 A	12/1986	Handler et al.
3,882,744 A	5/1975	McCarroll	4,637,188 A	1/1987	Crothers
3,886,413 A	5/1975	Dow et al.	4,637,289 A	1/1987	Ramsden
3,889,567 A	6/1975	Sato et al.	4,644,832 A	2/1987	Smith
3,922,785 A	12/1975	Fushiya	4,653,189 A	3/1987	Andreasson
3,924,688 A	12/1975	Cooper et al.	4,657,428 A	4/1987	Wiley
3,931,727 A	1/1976	Luenser	4,672,500 A	6/1987	Tholome et al.
3,935,777 A	2/1976	Bassett	4,675,664 A	6/1987	Cloutier et al.
3,945,286 A	3/1976	Smith	4,679,719 A	7/1987	Kramer
3,946,631 A	3/1976	Malm	4,722,021 A	1/1988	Hornung et al.
3,947,734 A	3/1976	Fyler	4,751,603 A	6/1988	Kwan
3,949,636 A	4/1976	Ball et al.	4,756,220 A	7/1988	Olsen et al.
3,953,770 A	4/1976	Hayashi	4,757,881 A	7/1988	Jonsson et al.
3,960,310 A	6/1976	Nussbaum	4,792,965 A	12/1988	Morgan
3,967,161 A	6/1976	Lichtblau	4,805,504 A	2/1989	Fushiya et al.
3,974,565 A	8/1976	Ellis	4,840,135 A	6/1989	Yamauchi
3,975,600 A	8/1976	Marston	4,845,476 A	7/1989	Rangeard et al.
3,978,624 A	9/1976	Merkel et al.	4,864,455 A	9/1989	Shimomura et al.
3,994,192 A	11/1976	Faig	4,875,398 A	10/1989	Taylor et al.
4,007,679 A	2/1977	Edwards	4,896,607 A	1/1990	Hall et al.
4,016,490 A	4/1977	Weckenmann et al.	4,906,962 A	3/1990	Duimstra
4,026,174 A	5/1977	Fierro	4,907,679 A *	3/1990	Menke ..... 188/189
4,026,177 A	5/1977	Lokey	4,934,233 A	6/1990	Brundage et al.
4,029,159 A	6/1977	Nymann	4,936,876 A	6/1990	Reyes
4,047,156 A	9/1977	Atkins	4,937,554 A	6/1990	Herman
4,048,886 A	9/1977	Zettler	4,965,909 A	10/1990	McCullough et al.
4,060,160 A	11/1977	Lieber	4,975,798 A	12/1990	Edwards et al.
4,070,940 A	1/1978	McDaniel et al.	5,020,406 A	6/1991	Sasaki et al.
4,075,961 A	2/1978	Harris	5,025,175 A	6/1991	Dubois, III
4,077,161 A	3/1978	Wyle et al.	5,046,426 A	9/1991	Julien et al.
4,085,303 A	4/1978	McIntyre et al.	5,052,255 A *	10/1991	Gaines ..... 83/62.1
4,090,345 A	5/1978	Harkness	5,074,047 A	12/1991	King
4,091,698 A	5/1978	Obear et al.	5,081,406 A	1/1992	Hughes et al.
4,106,378 A	8/1978	Kaiser	5,082,316 A	1/1992	Wardlaw
4,117,752 A	10/1978	Yoneda	5,083,973 A	1/1992	Townsend
4,145,940 A *	3/1979	Woloveke et al. .... 83/68	5,086,890 A	2/1992	Turczyn et al.
4,152,833 A	5/1979	Phillips	5,094,000 A	3/1992	Becht et al.
4,161,649 A	7/1979	Klos et al.	5,119,555 A	6/1992	Johnson
4,175,452 A	11/1979	Idel	5,122,091 A	6/1992	Townsend
4,190,000 A	2/1980	Shaull et al.	5,174,349 A	12/1992	Svetlik et al.
4,195,722 A	4/1980	Anderson et al.	5,184,534 A	2/1993	Lee
4,199,930 A	4/1980	Lebet et al.	5,198,702 A	3/1993	McCullough et al.
4,249,117 A	2/1981	Leukhardt et al.	5,199,343 A	4/1993	OBanion
4,249,442 A	2/1981	Fittery	5,201,684 A	4/1993	DeBois, III
4,262,278 A	4/1981	Howard et al.	5,207,253 A	5/1993	Hoshino et al.
4,267,914 A	5/1981	Saar	5,212,621 A	5/1993	Panter
4,270,427 A	6/1981	Colberg et al.	5,218,189 A	6/1993	Hutchison
4,276,799 A	7/1981	Muehling	5,231,359 A	7/1993	Masuda et al.
4,291,794 A	9/1981	Bauer	5,231,906 A	8/1993	Kogej
4,305,442 A	12/1981	Currie	5,239,978 A	8/1993	Plangetis



# US 7,024,975 B2

Page 4

5,245,879 A	9/1993	McKeon	6,352,137 B1	3/2002	Stegall et al.
5,257,570 A	11/1993	Shiotani et al.	6,366,099 B1	4/2002	Reddi
5,265,510 A	11/1993	Hoyer-Ellefsen	6,376,939 B1	4/2002	Suzuki et al.
5,272,946 A	12/1993	McCullough et al.	6,404,098 B1	6/2002	Kayama et al.
5,276,431 A	1/1994	Piccoli et al.	6,405,624 B1	6/2002	Sutton
5,285,708 A	2/1994	Bosten et al.	6,418,829 B1	7/2002	Pilchowski
5,320,382 A	6/1994	Goldstein et al.	6,420,814 B1	7/2002	Bobbio
5,321,230 A	6/1994	Shanklin et al.	6,427,570 B1	8/2002	Miller et al.
5,331,875 A	7/1994	Mayfield	6,430,007 B1	8/2002	Jabbari
5,353,670 A	10/1994	Metzger, Jr.	6,431,425 B1	8/2002	Moorman et al.
5,377,554 A	1/1995	Reulein et al.	6,450,077 B1	9/2002	Ceroll et al.
5,377,571 A	1/1995	Josephs	6,453,786 B1	9/2002	Ceroll et al.
5,392,568 A	2/1995	Howard, Jr. et al.	6,460,442 B1	10/2002	Talesky et al.
5,392,678 A	2/1995	Sasaki et al.	6,471,106 B1	10/2002	Reining
5,401,928 A	3/1995	Kelley	6,479,958 B1	11/2002	Thompson et al.
5,411,221 A	5/1995	Collins et al.	D466,913 S	12/2002	Ceroll et al.
5,436,613 A	7/1995	Ghosh et al.	6,492,802 B1	12/2002	Bielski
5,451,750 A	9/1995	An	D469,354 S	1/2003	Curtsinger
5,453,903 A	9/1995	Chow	6,502,493 B1	1/2003	Eccardt et al.
5,471,888 A	12/1995	McCormick	6,536,536 B1	3/2003	Gass et al.
5,480,009 A	1/1996	Wieland et al.	6,543,324 B1	4/2003	Dils
5,503,059 A	4/1996	Pacholok	6,546,835 B1	4/2003	Wang
5,510,685 A	4/1996	Grasselli	6,575,067 B1	6/2003	Parks et al.
5,513,548 A	5/1996	Garuglieri	6,578,460 B1	6/2003	Sartori
5,534,836 A	7/1996	Schenkel et al.	6,578,856 B1	6/2003	Kahle
5,572,916 A	11/1996	Takano	6,595,096 B1	7/2003	Ceroll et al.
5,587,618 A	12/1996	Hathaway	D478,917 S	8/2003	Ceroll et al.
5,592,353 A	1/1997	Shinohara et al.	6,601,493 B1	8/2003	Croft
5,606,889 A	3/1997	Bielinski et al.	6,607,015 B1	8/2003	Chen
5,623,860 A	4/1997	Schoene et al.	D479,538 S	9/2003	Welsh et al.
5,648,644 A	7/1997	Nagel	6,617,720 B1	9/2003	Egan, III et al.
5,659,454 A	8/1997	Vermesse	6,619,348 B1	9/2003	Wang
5,667,152 A	9/1997	Mooring	6,640,683 B1	11/2003	Lee
5,671,633 A	9/1997	Wagner	6,644,157 B1	11/2003	Huang
5,695,306 A	12/1997	Nygren, Jr.	6,647,847 B1	11/2003	Hewitt et al.
5,700,165 A	12/1997	Harris et al.	6,659,233 B1	12/2003	DeVlieg
5,724,875 A	3/1998	Meredith et al.	6,736,042 B1	5/2004	Behne et al.
5,730,165 A	3/1998	Philipp	6,742,430 B1	6/2004	Chen
5,741,048 A	4/1998	Eccleston	6,796,208 B1	9/2004	Jorgensen
5,755,148 A	5/1998	Stumpf et al.	6,826,988 B1	12/2004	Gass et al.
5,771,742 A	6/1998	Bokaie et al.	6,857,345 B1	2/2005	Gass et al.
5,782,001 A	7/1998	Gray	6,874,397 B1	4/2005	Chang
5,787,779 A	8/1998	Garuglieri	6,874,399 B1	4/2005	Lee
5,791,057 A	8/1998	Nakamura et al.	6,920,814 B1	7/2005	Gass et al.
5,791,223 A	8/1998	Lanzer	6,945,148 B1	9/2005	Gass et al.
5,791,224 A	8/1998	Suzuki et al.	6,945,149 B1	9/2005	Gass et al.
5,791,441 A	8/1998	Matos et al.	2001/0032534 A1	10/2001	Cerroll et al.
5,819,619 A	10/1998	Miller et al.	2002/0017176 A1 *	2/2002	Gass et al. .... 83/13
5,852,951 A	12/1998	Santi	2002/0017178 A1 *	2/2002	Gass et al. .... 83/58
5,861,809 A	1/1999	Eckstein et al.	2002/0017179 A1 *	2/2002	Gass et al. .... 83/58
5,875,698 A	3/1999	Ceroll et al.	2002/0017182 A1 *	2/2002	Gass et al. .... 83/58
5,921,367 A	7/1999	Kashioka et al.	2002/0017184 A1 *	2/2002	Gass et al. .... 83/477.2
5,930,096 A	7/1999	Kim	2002/0017336 A1 *	2/2002	Gass et al. .... 144/2.1
5,937,720 A	8/1999	Itzov	2002/0020261 A1 *	2/2002	Gass et al. .... 83/58
5,942,975 A	8/1999	Sorensen	2002/0020263 A1 *	2/2002	Gass et al. .... 83/58
5,943,932 A	8/1999	Sberveglieri	2002/0020271 A1 *	2/2002	Gass et al. .... 83/477.2
5,950,514 A	9/1999	Benedict et al.	2002/0056348 A1 *	5/2002	Gass et al. .... 83/62.1
5,963,173 A	10/1999	Lian et al.	2002/0056349 A1 *	5/2002	Gass et al. .... 83/62.1
5,974,927 A	11/1999	Tsune	2002/0056350 A1 *	5/2002	Gass et al. .... 83/62.1
5,989,116 A	11/1999	Johnson et al.	2002/0059854 A1 *	5/2002	Gass et al. .... 83/62
6,018,284 A	1/2000	Rival et al.	2002/0066346 A1 *	6/2002	Gass et al. .... 83/58
6,037,729 A	3/2000	Woods et al.	2002/0096030 A1	7/2002	Wang
6,052,884 A	4/2000	Steckler et al.	2002/0109036 A1	8/2002	Denen et al.
6,095,092 A	8/2000	Chou	2002/0170399 A1 *	11/2002	Gass ..... 83/62.1
6,119,984 A	9/2000	Devine	2003/0005588 A1 *	1/2003	Gass et al. .... 30/382
6,133,818 A	10/2000	Hsieh et al.	2003/0020336 A1 *	1/2003	Gass et al. .... 307/326
6,141,192 A	10/2000	Garzon	2003/0037651 A1 *	2/2003	Gass et al. .... 83/62.1
6,148,504 A	11/2000	Schmidt et al.	2003/0037655 A1	2/2003	Chin-Chin
6,150,826 A	11/2000	Hokodate et al.	2003/0074873 A1 *	4/2003	Freiberg et al. .... 56/10.4
6,170,370 B1	1/2001	Sommerville	2003/0089212 A1	5/2003	Parks et al.
6,244,149 B1	6/2001	Ceroll et al.	2003/0101857 A1	6/2003	Chuang
6,257,061 B1	7/2001	Nonoyama et al.	2003/0109798 A1	6/2003	Kermani
6,330,848 B1	12/2001	Nishio et al.	2004/0011177 A1	1/2004	Huang

2004/0060404	A1	4/2004	Metzger, Jr.
2004/0104085	A1	6/2004	Lang et al.
2004/0159198	A1	8/2004	Peot et al.
2004/0194594	A1	10/2004	Dils et al.
2004/0200329	A1	10/2004	Sako
2004/0226424	A1	11/2004	OBanion et al.
2004/0226800	A1	11/2004	Pierga et al.
2005/0057206	A1	3/2005	Uneyama
2005/0092149	A1	5/2005	Hartmann
2005/0139051	A1	6/2005	Gass et al.
2005/0139056	A1	6/2005	Gass et al.
2005/0139057	A1	6/2005	Gass et al.
2005/0139058	A1	6/2005	Gass et al.
2005/0139459	A1	6/2005	Gass et al.
2005/0155473	A1	7/2005	Gass
2005/0166736	A1	8/2005	Gass et al.
2005/0178259	A1	8/2005	Gass et al.
2005/0204885	A1	9/2005	Gass et al.

FOREIGN PATENT DOCUMENTS

CH	297525	6/1954
DE	76186	8/1921
DE	2800403	7/1979
DE	3427733	* 1/1986
DE	4235161	A1 5/1993
DE	4326313	2/1995
DE	19609771	6/1998
EP	146460	11/1988
EP	0362937	A2 4/1990
ES	2152184	1/2001
FR	2556643	6/1985

FR	2570017	3/1986
GB	598204	2/1948
GB	1132708	11/1968
GB	2096844	10/1982
GB	2142571	* 1/1985

OTHER PUBLICATIONS

Gordon Engineering Corp., Product Catalog, Oct. 1997, pp. cover, 1, 3 and back, Brookfield, Connecticut, US.  
Analog Devices, Inc., 3-Axis Capacitive Sensor—Preliminary Technical Data AD7103, pp. 1-40, © 1998.

\* cited by examiner

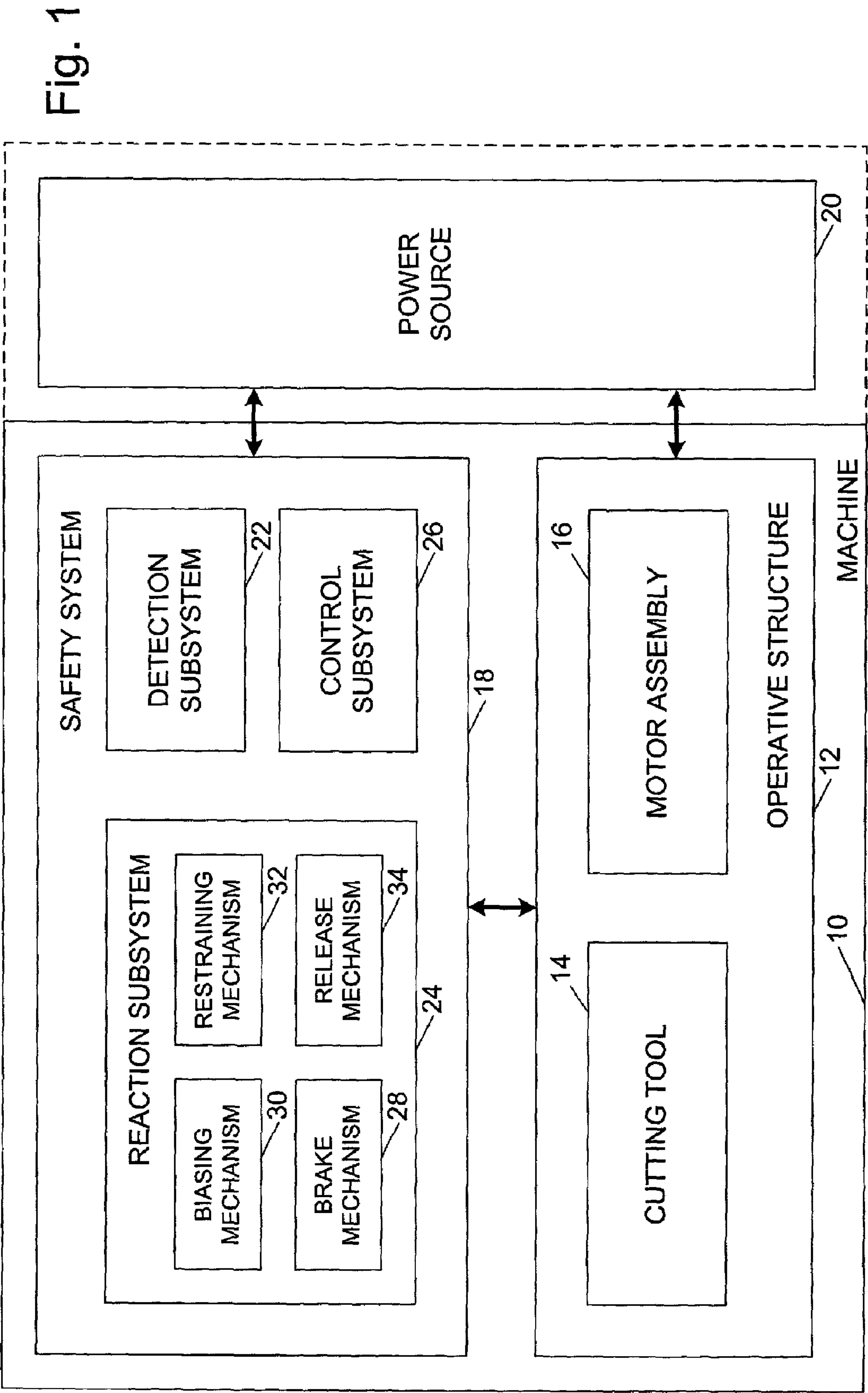
*Primary Examiner*—Boyer D. Ashley  
*Assistant Examiner*—Ghassem Alie

(57)

ABSTRACT

Woodworking machines are disclosed having cutting tools adapted to cut workpieces. The machines include a detection system adapted to detect one or more dangerous conditions between a person and the cutting tool. The machines also include a brake mechanism having one or more braking components adapted to engage and stop the cutting tool in response to the detection of a dangerous condition.

17 Claims, 13 Drawing Sheets





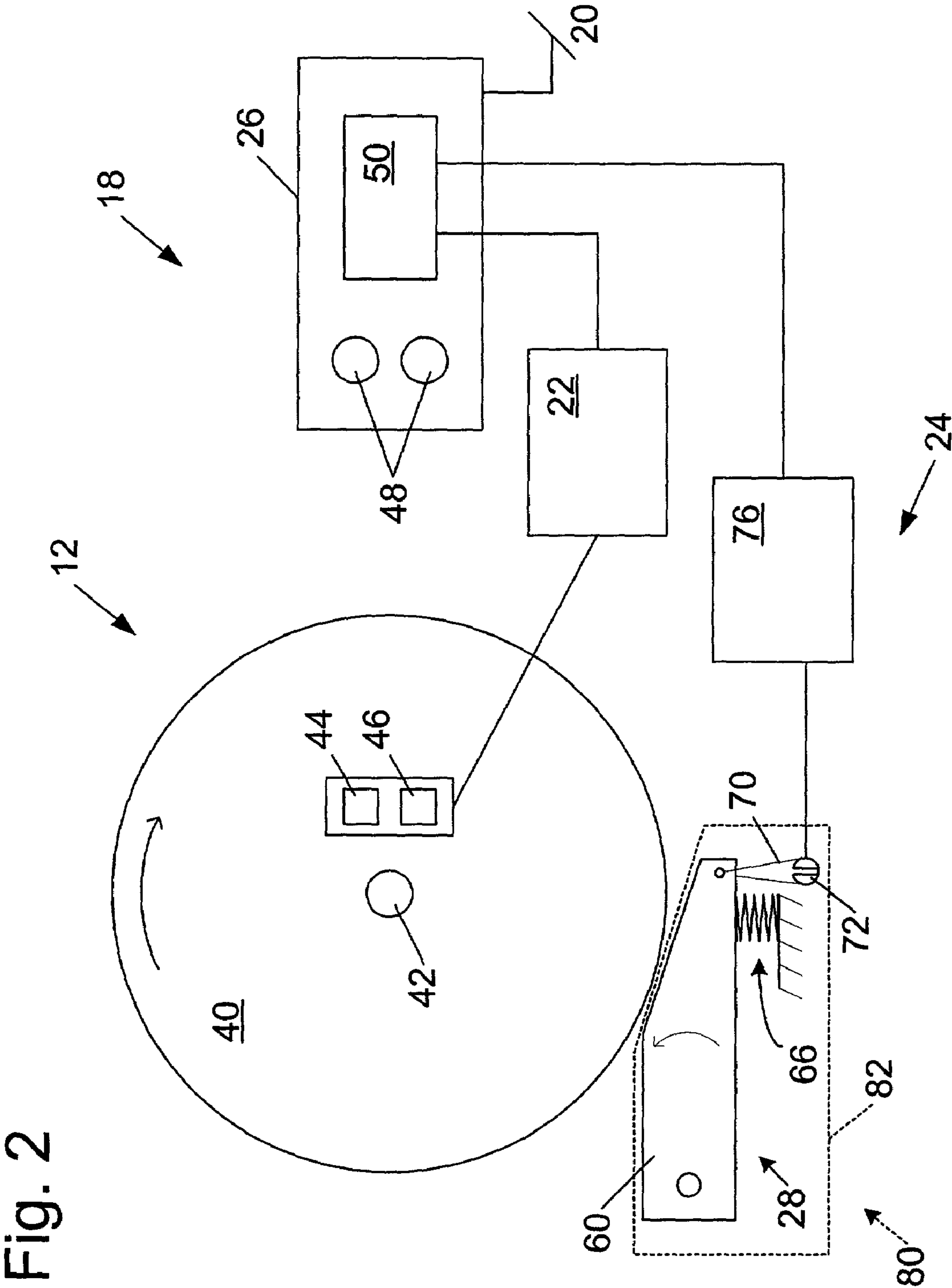


Fig. 3

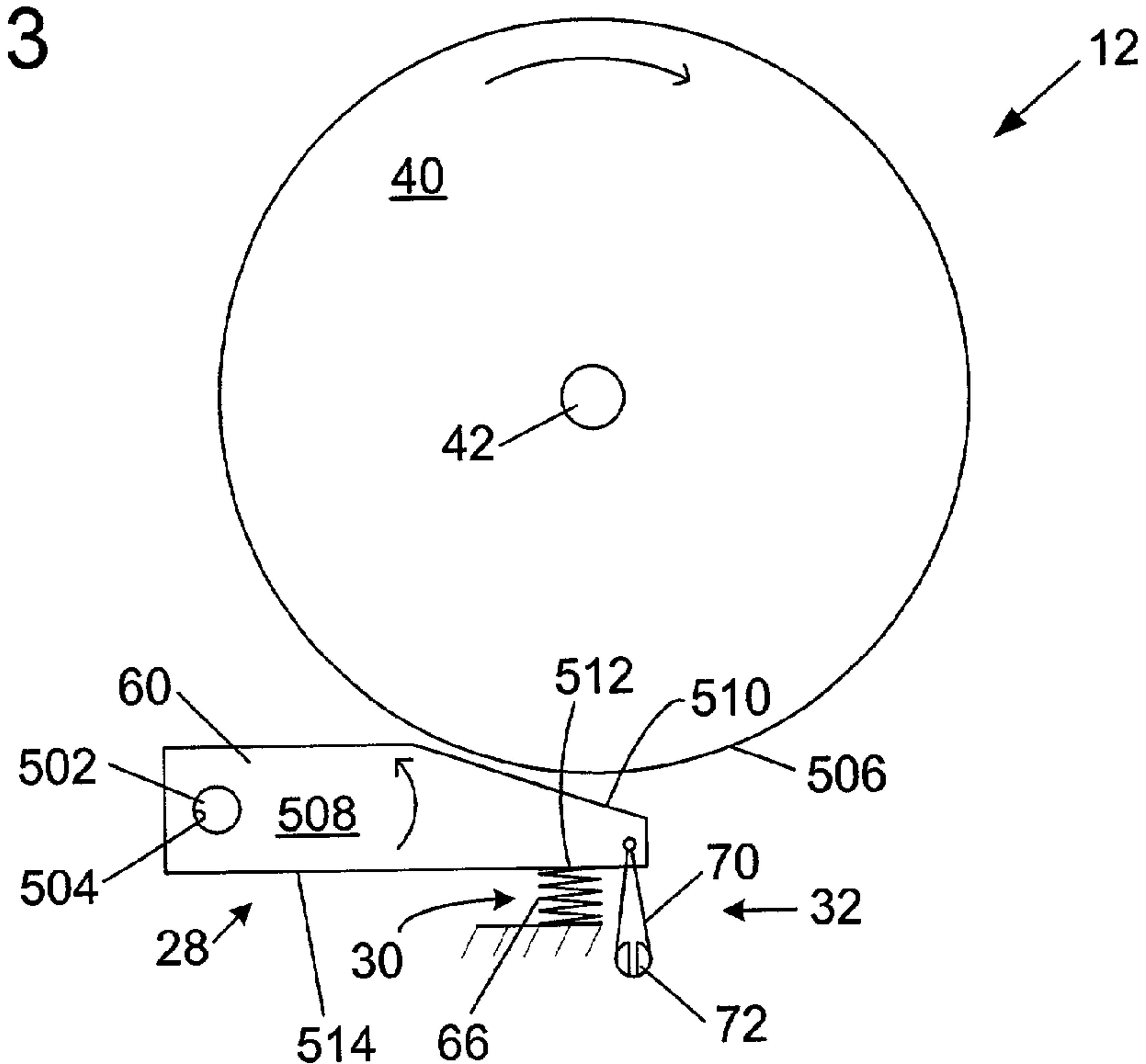


Fig. 4

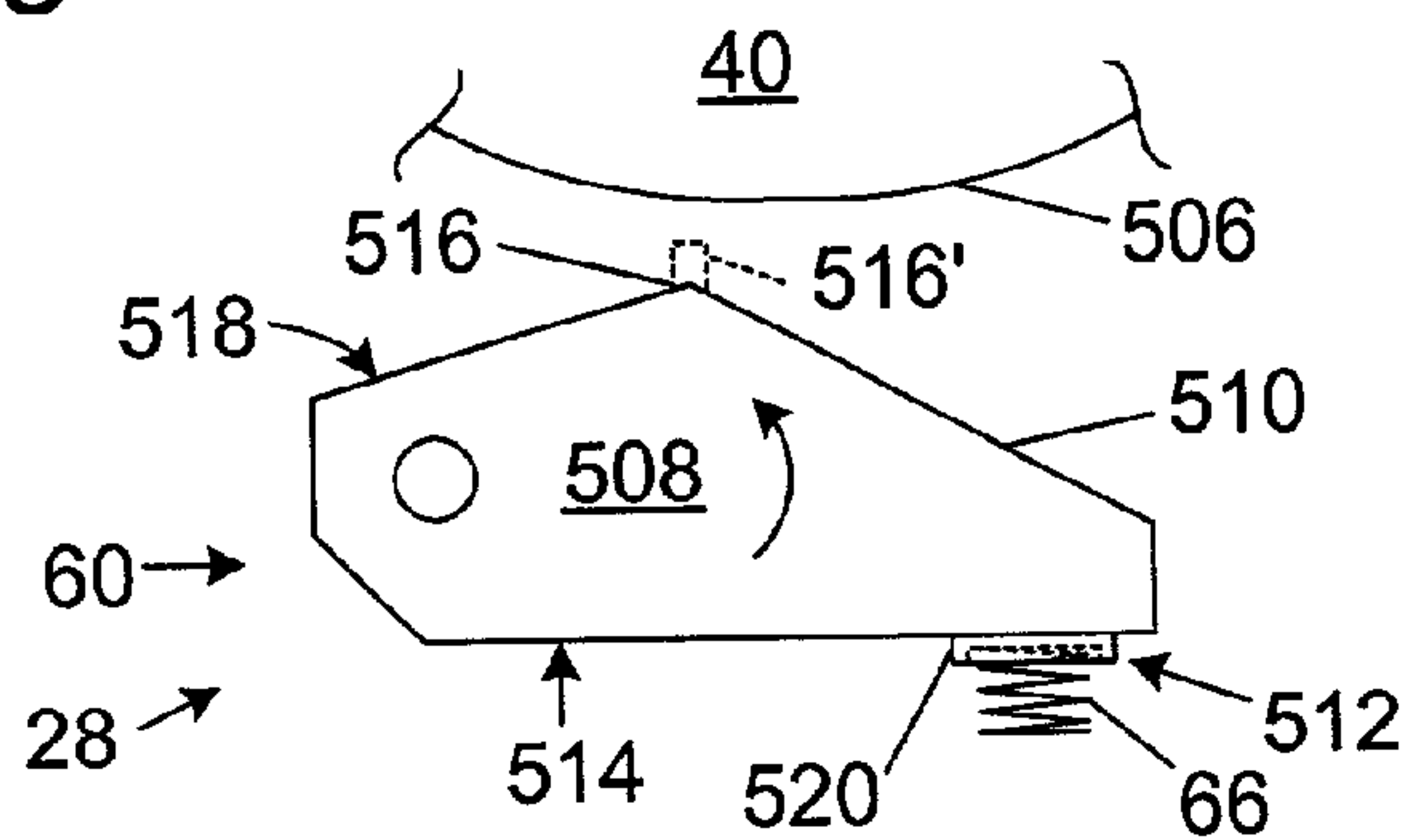


Fig. 5

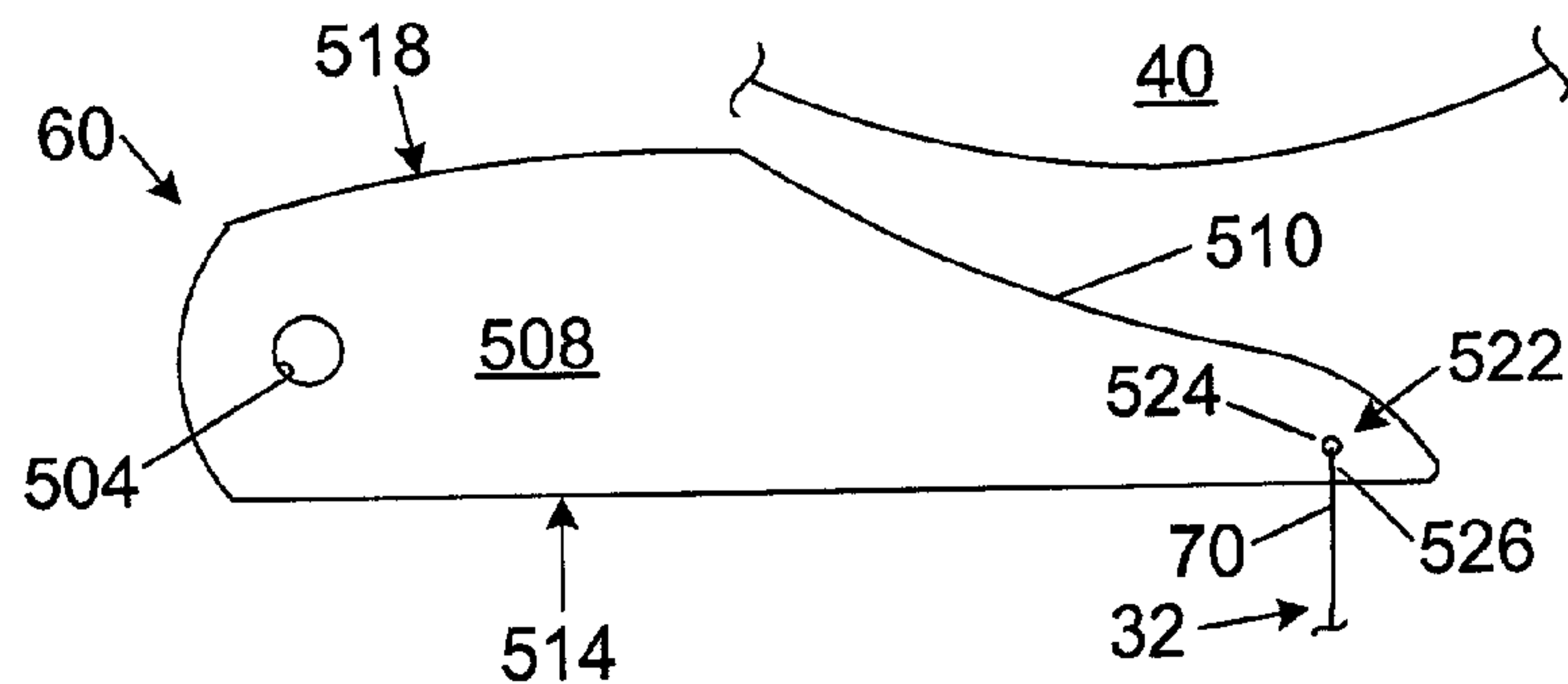




Fig. 6

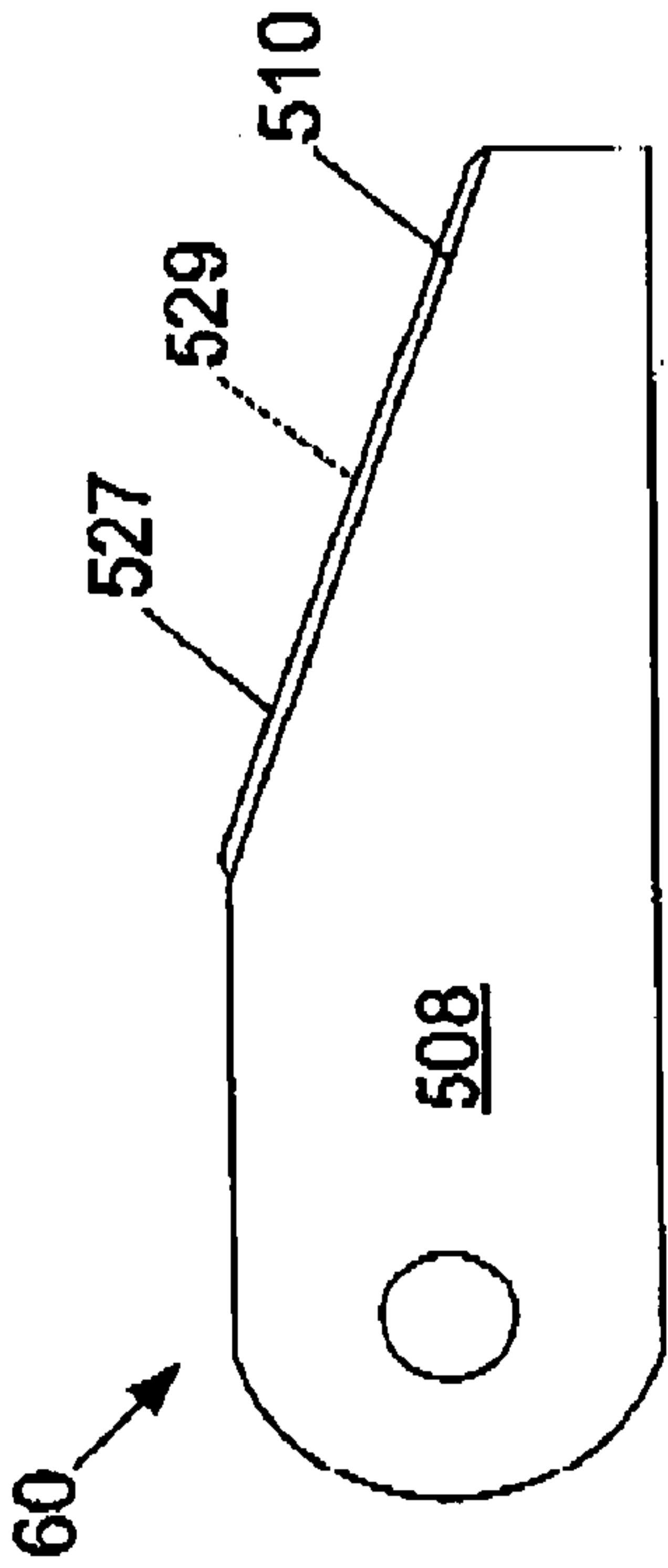


Fig. 8

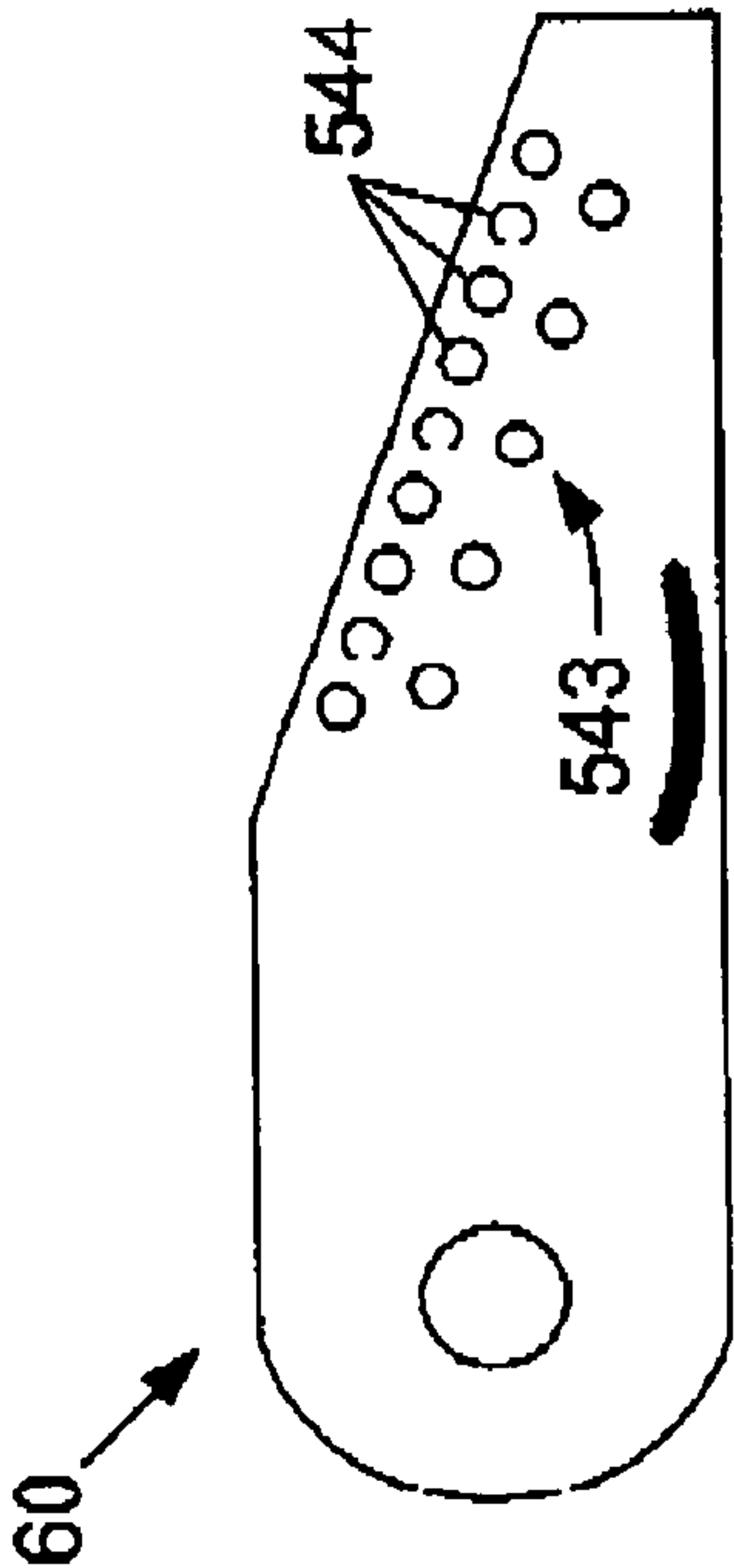


Fig. 9

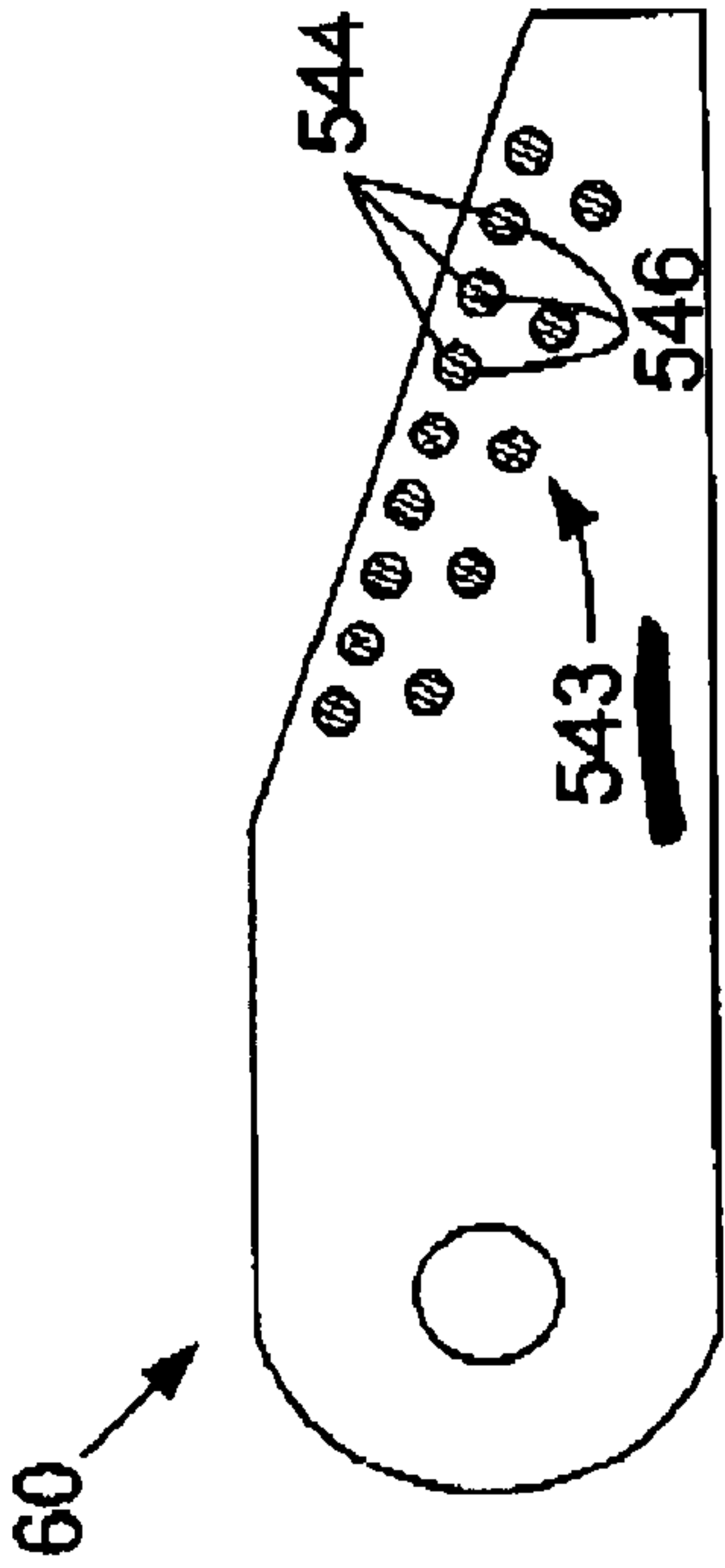


Fig. 7

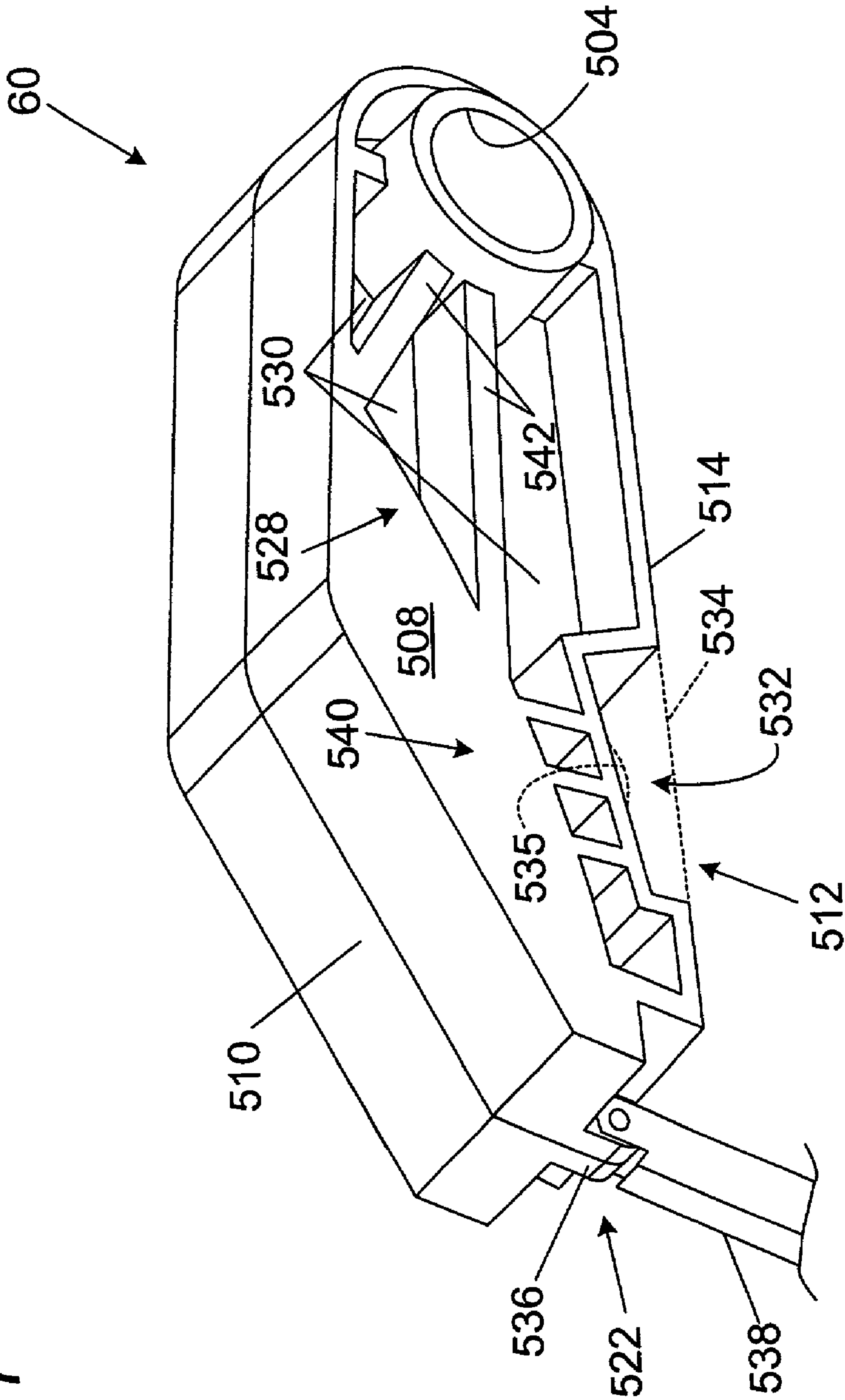


Fig. 10

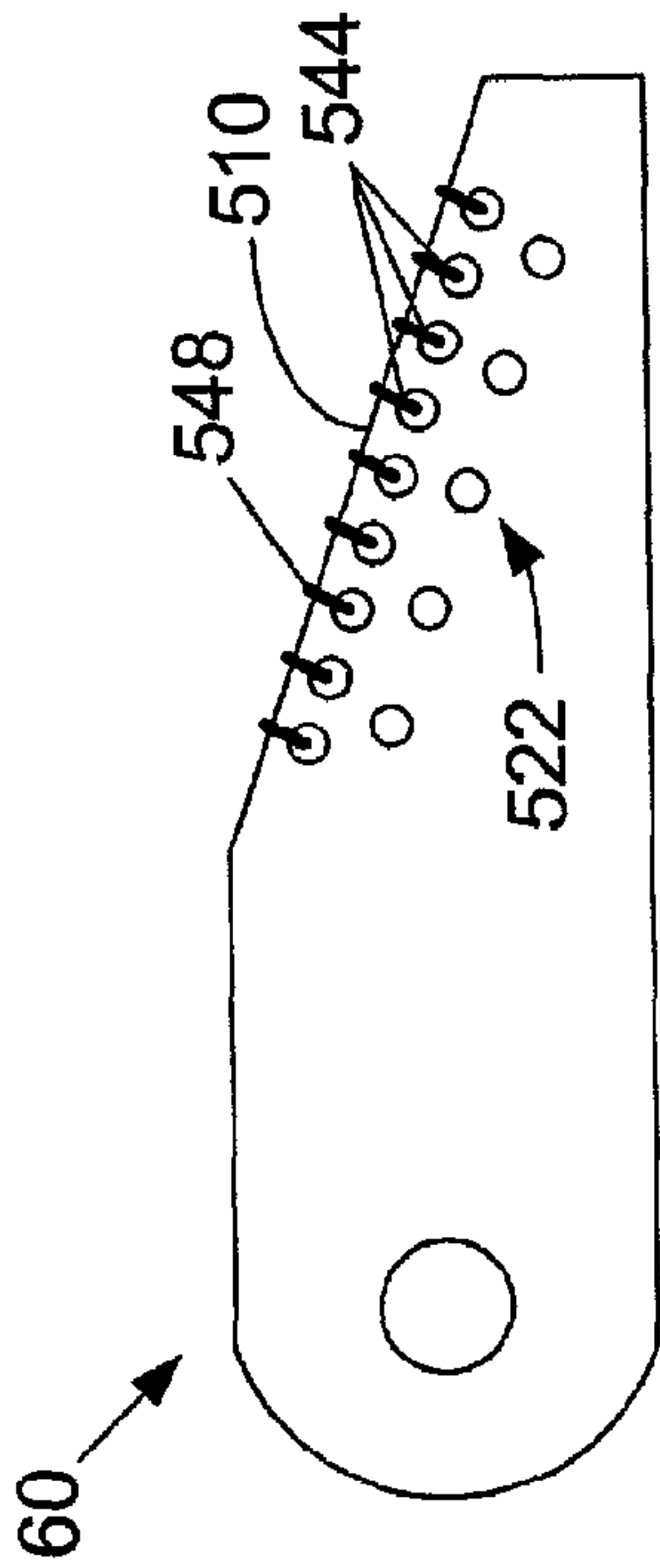


Fig. 11

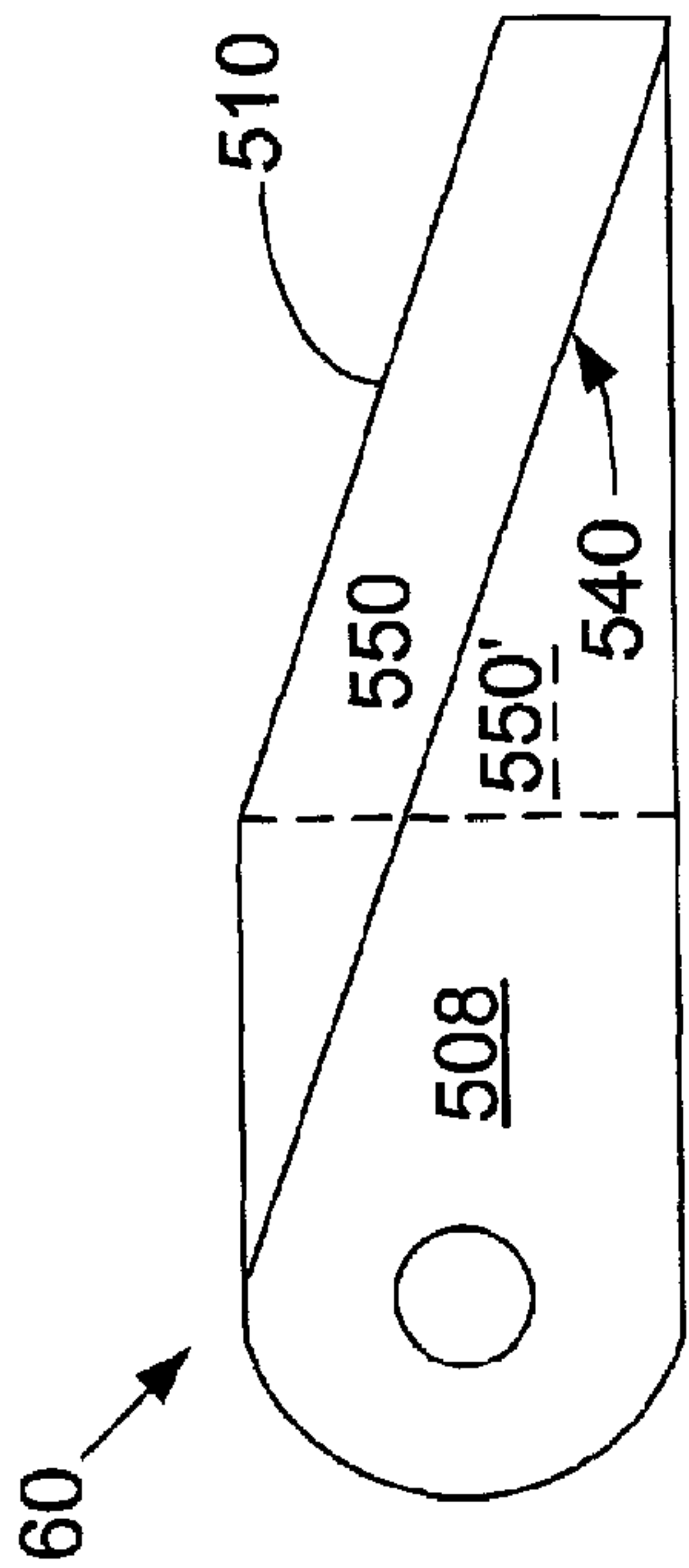


Fig. 12

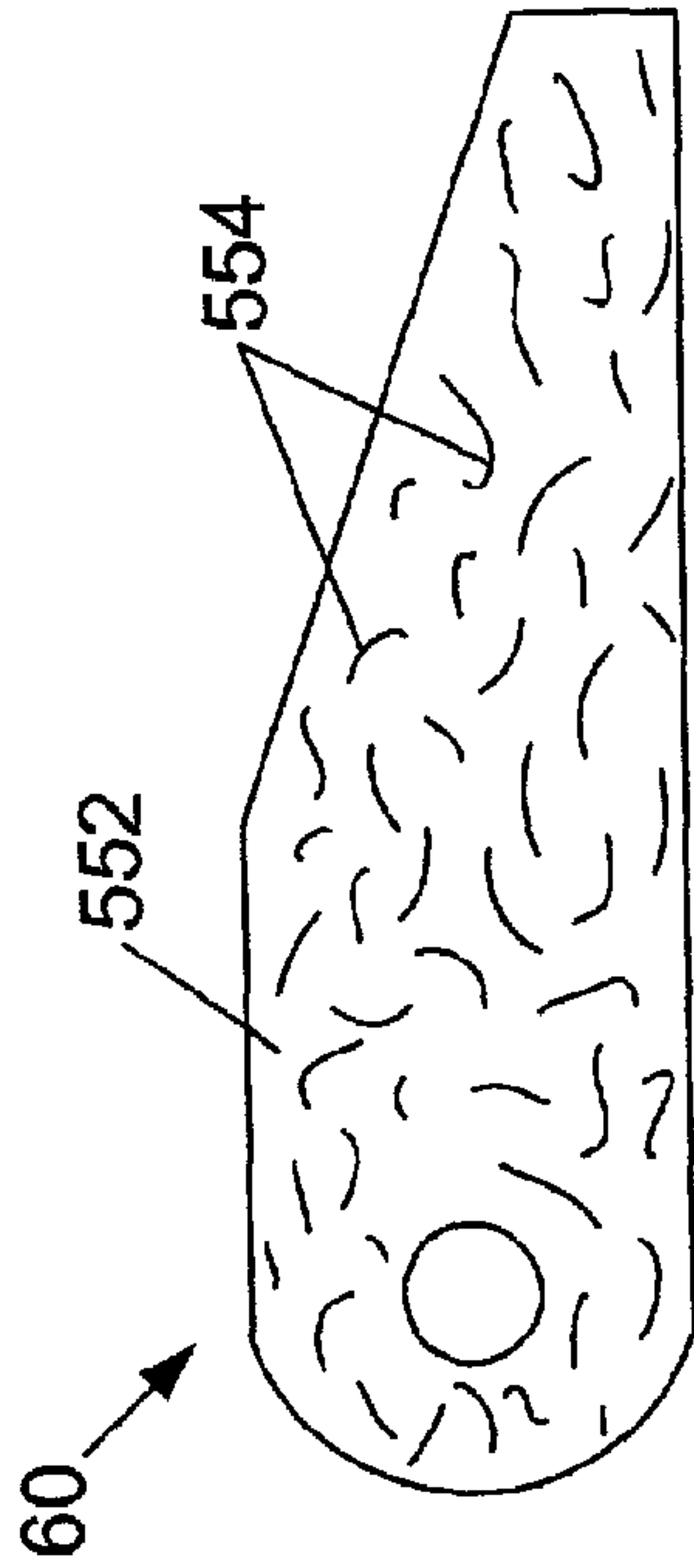


Fig. 13

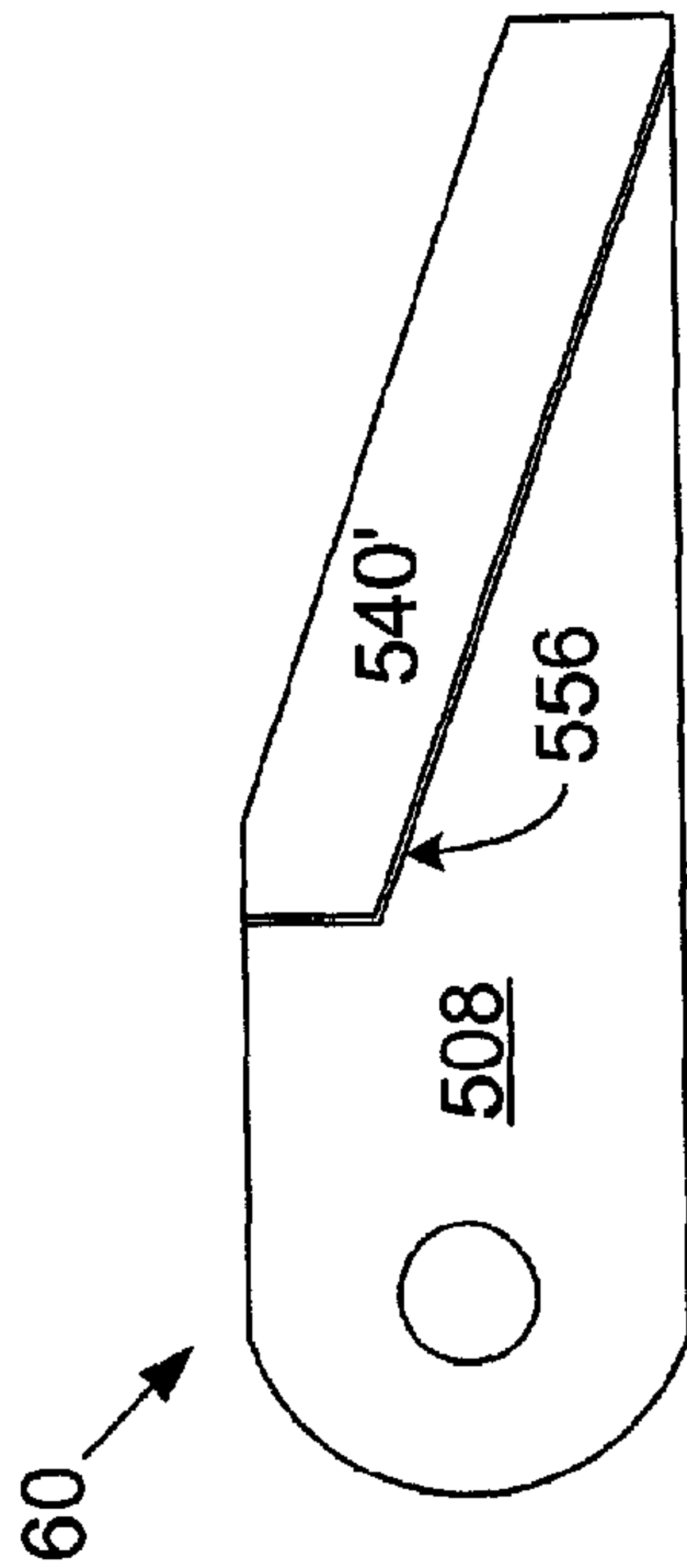




Fig. 14

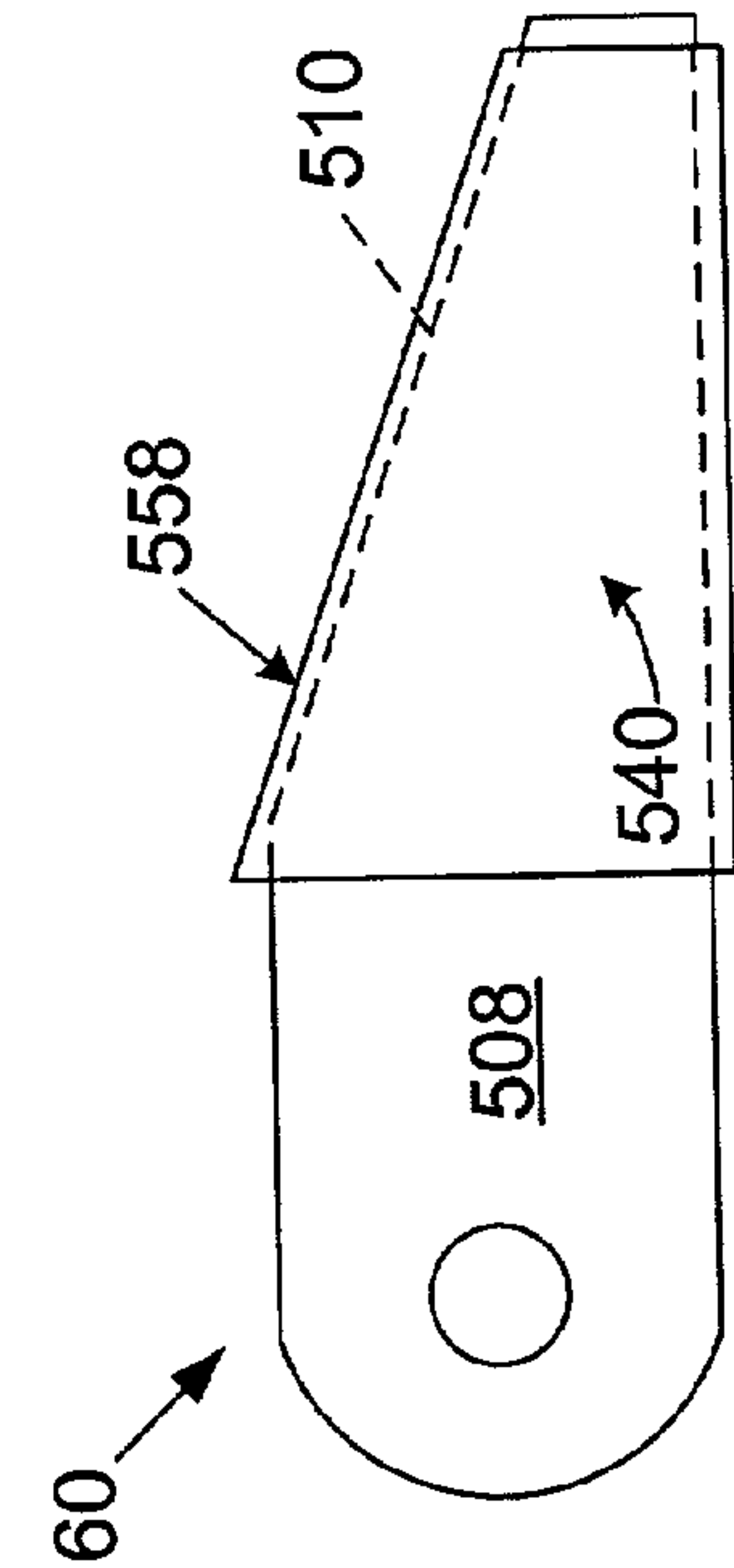


Fig. 15

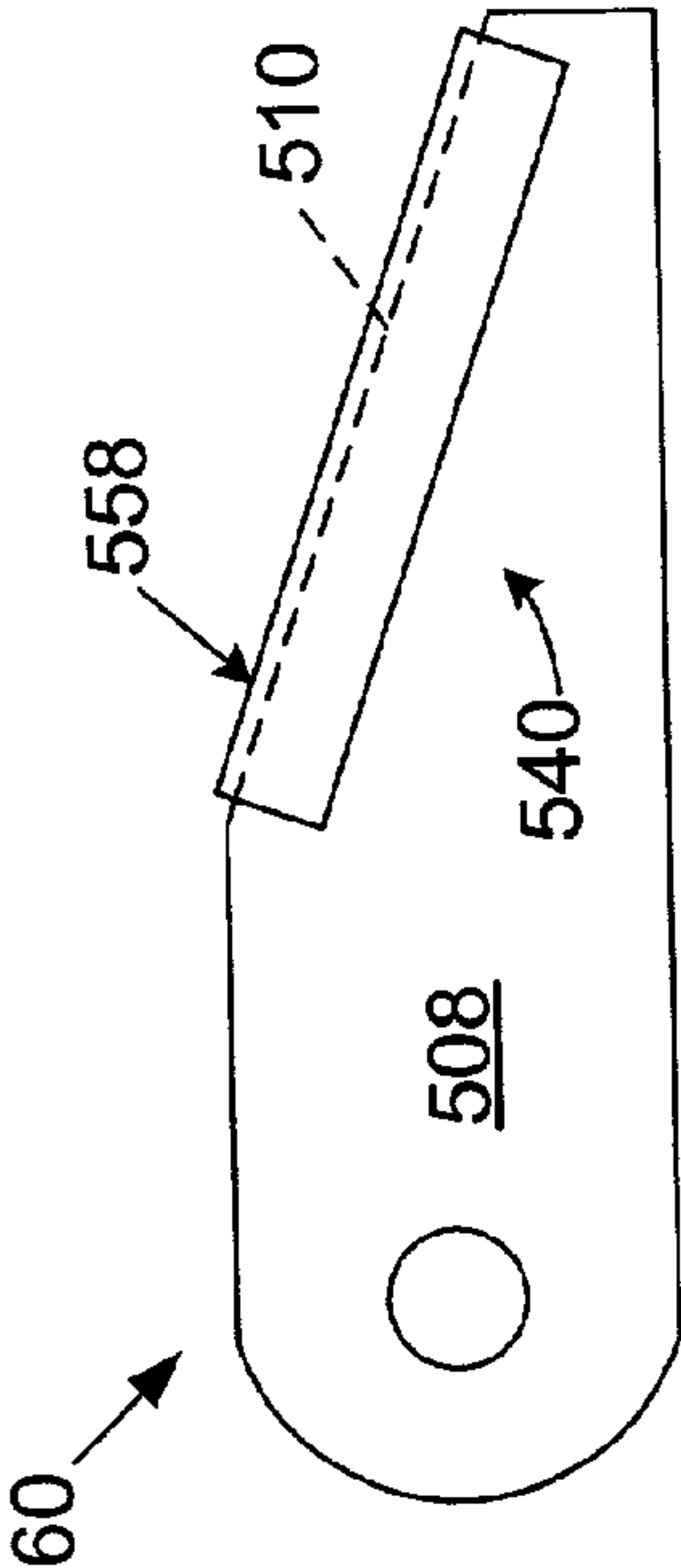


Fig. 28

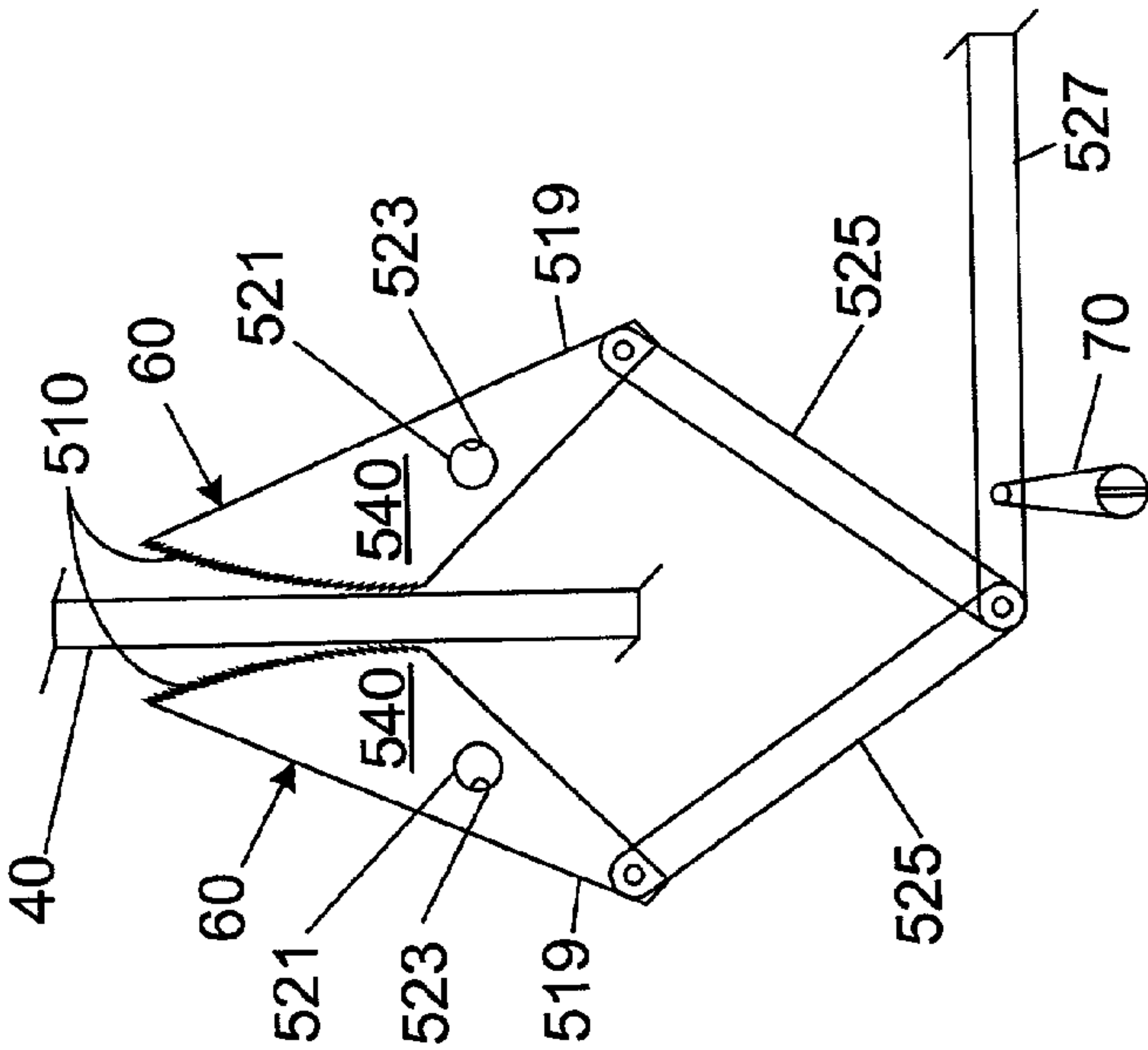


Fig. 16

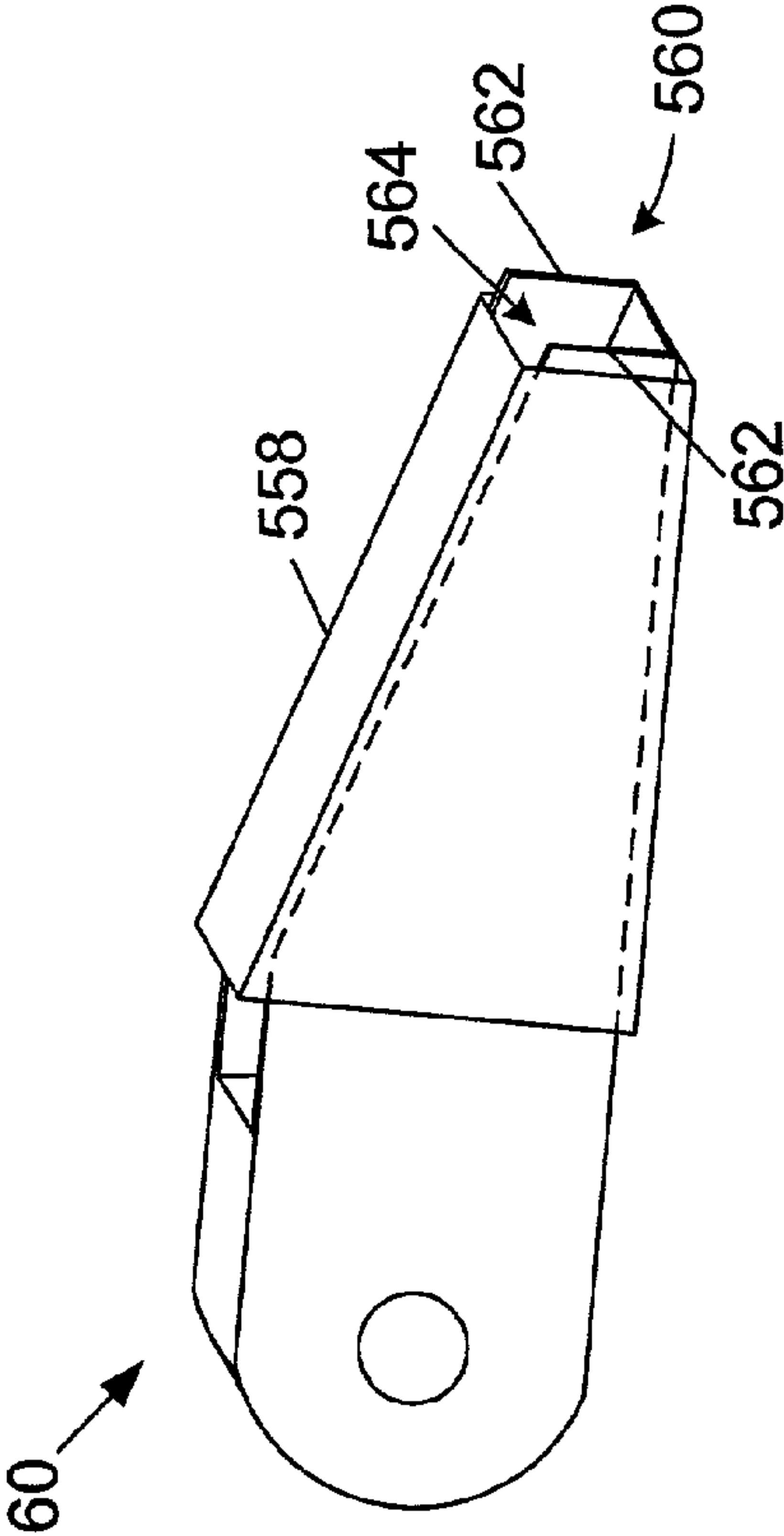


Fig. 17

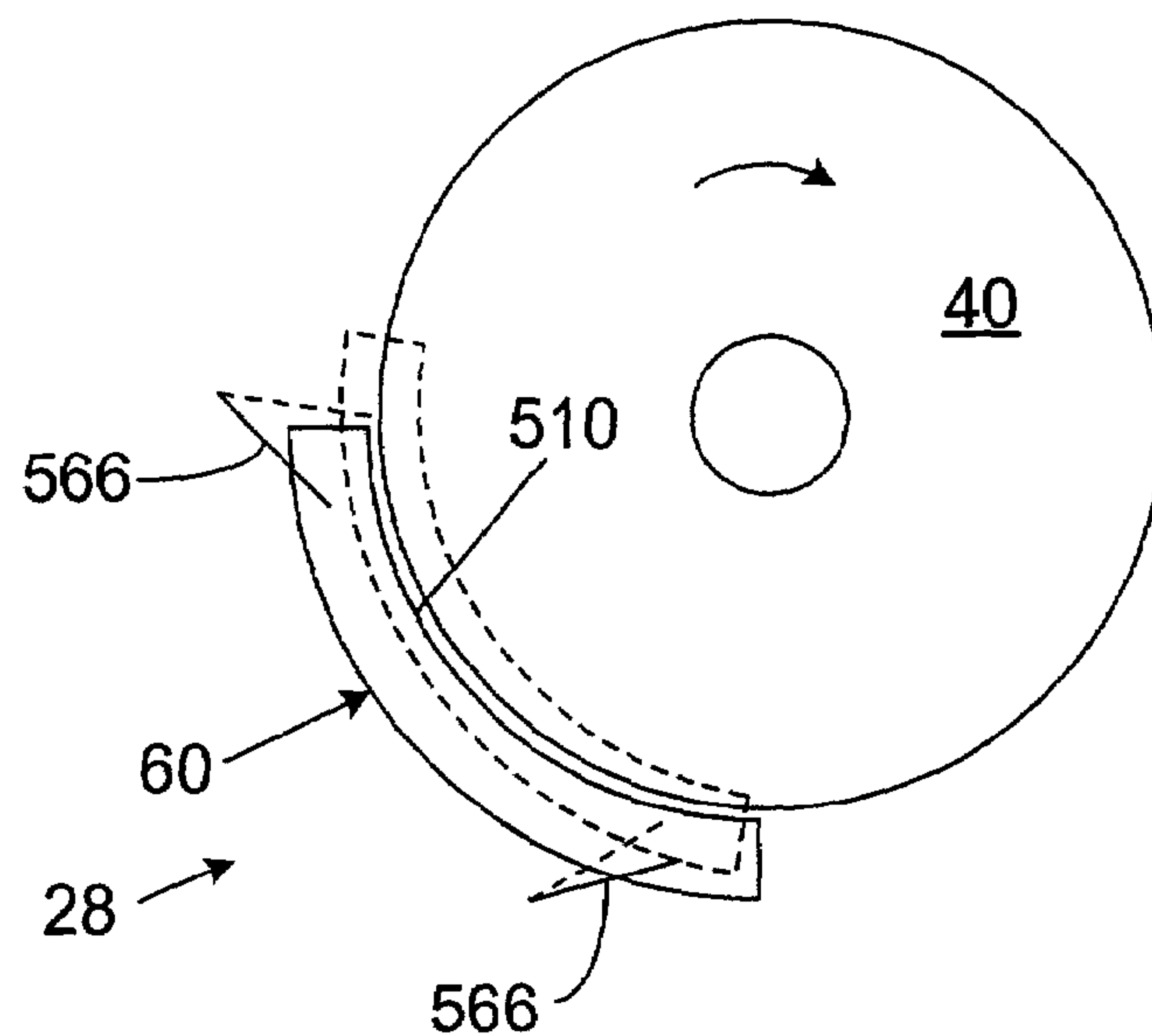


Fig. 18

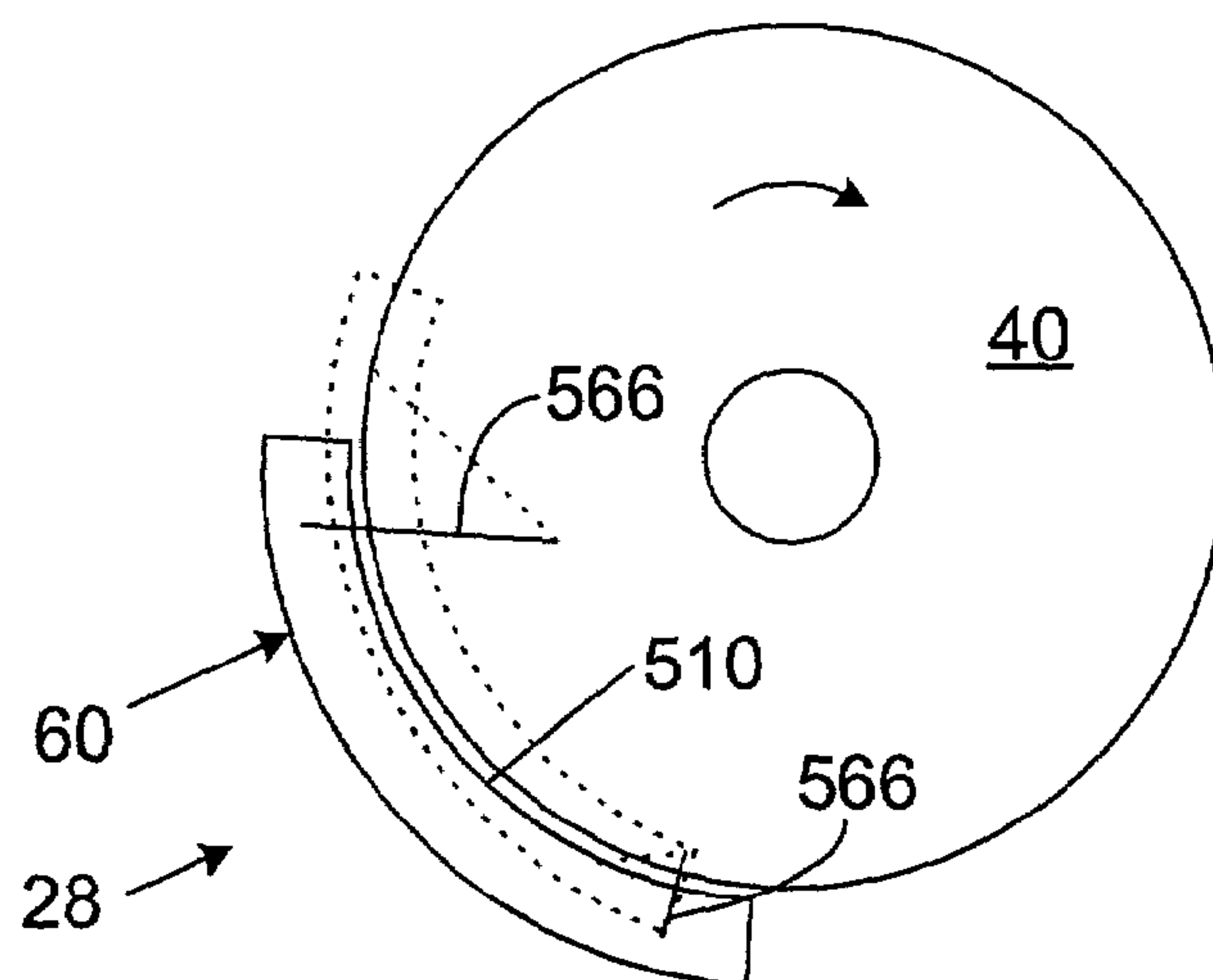


Fig. 19

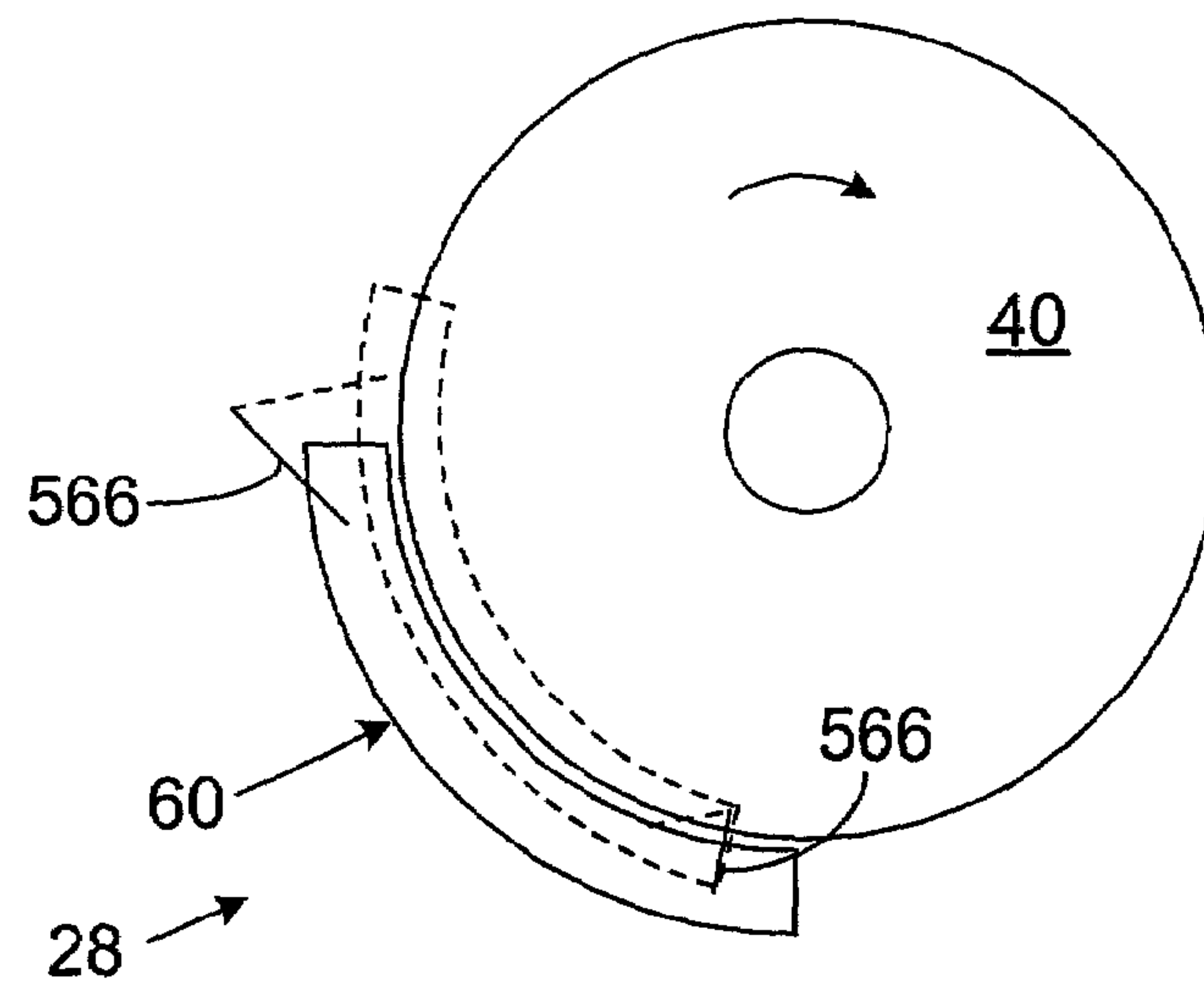


Fig. 20

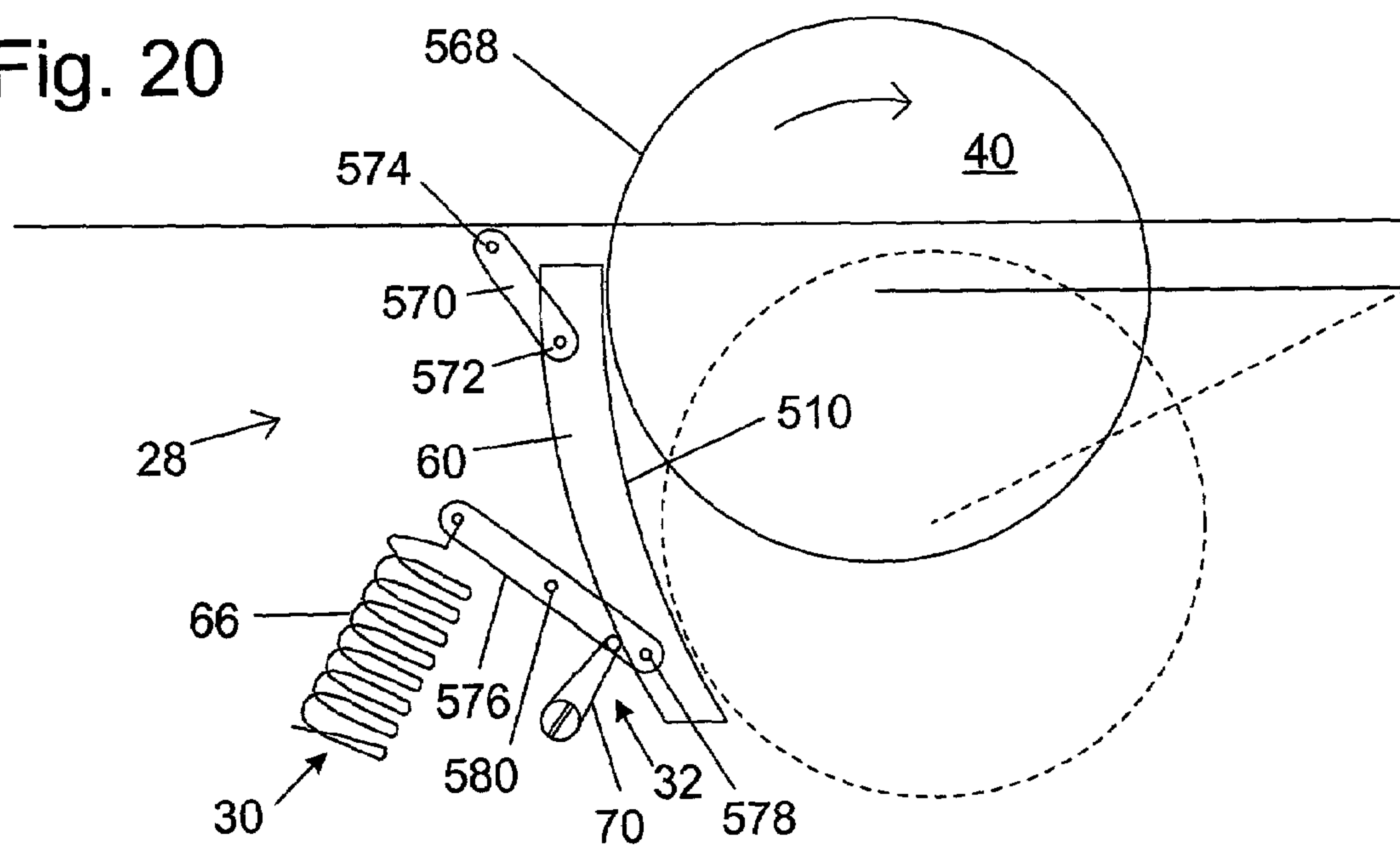


Fig. 21

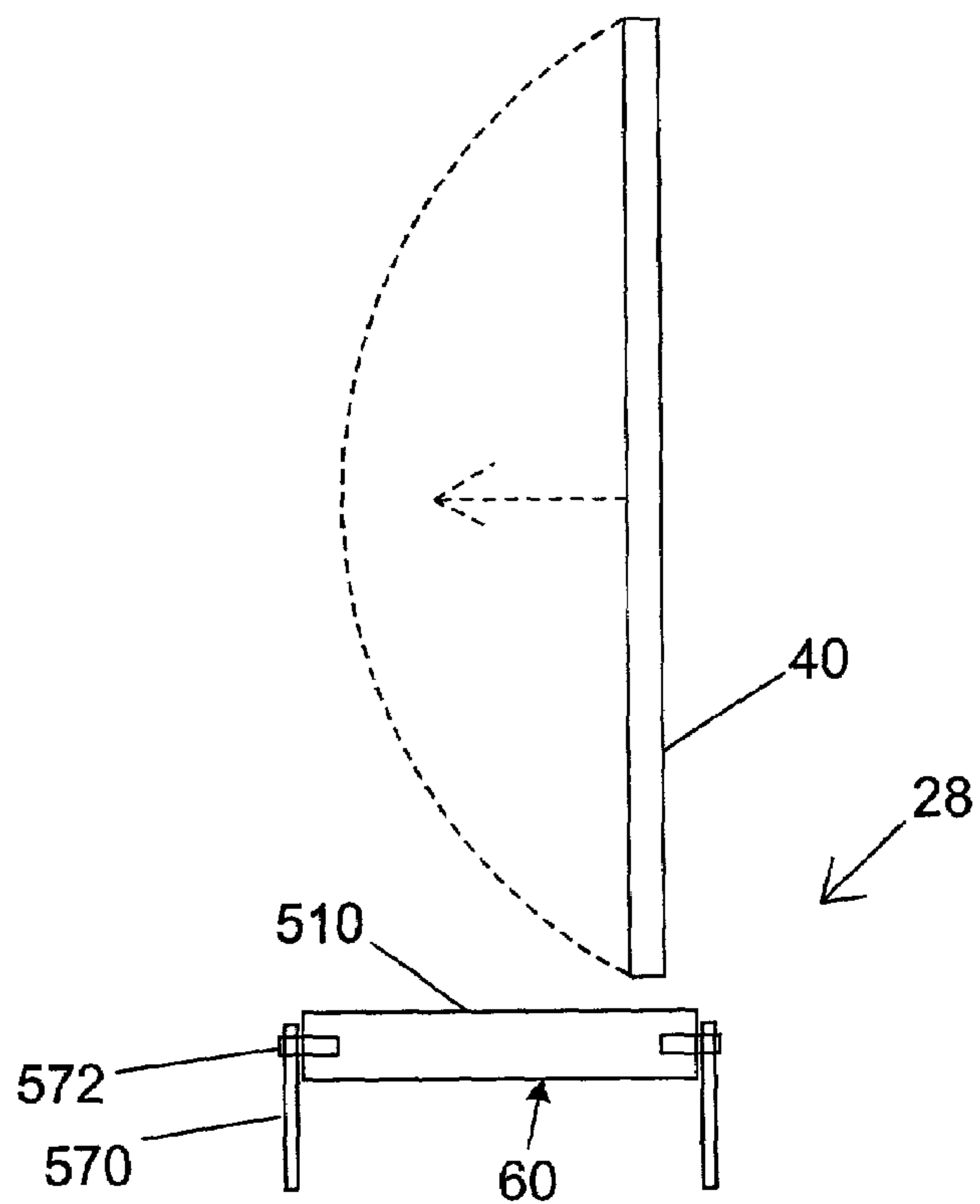
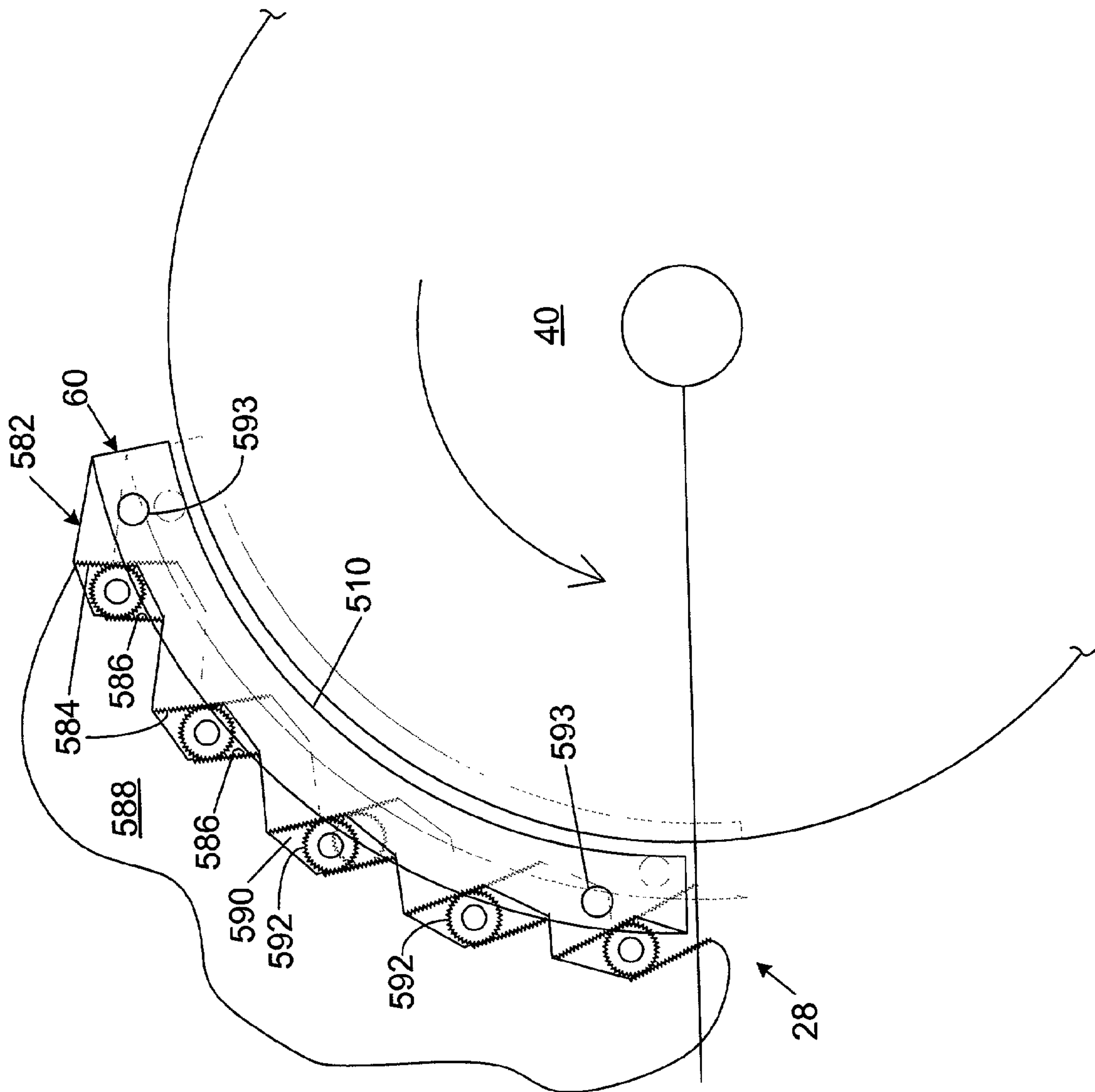




Fig. 22



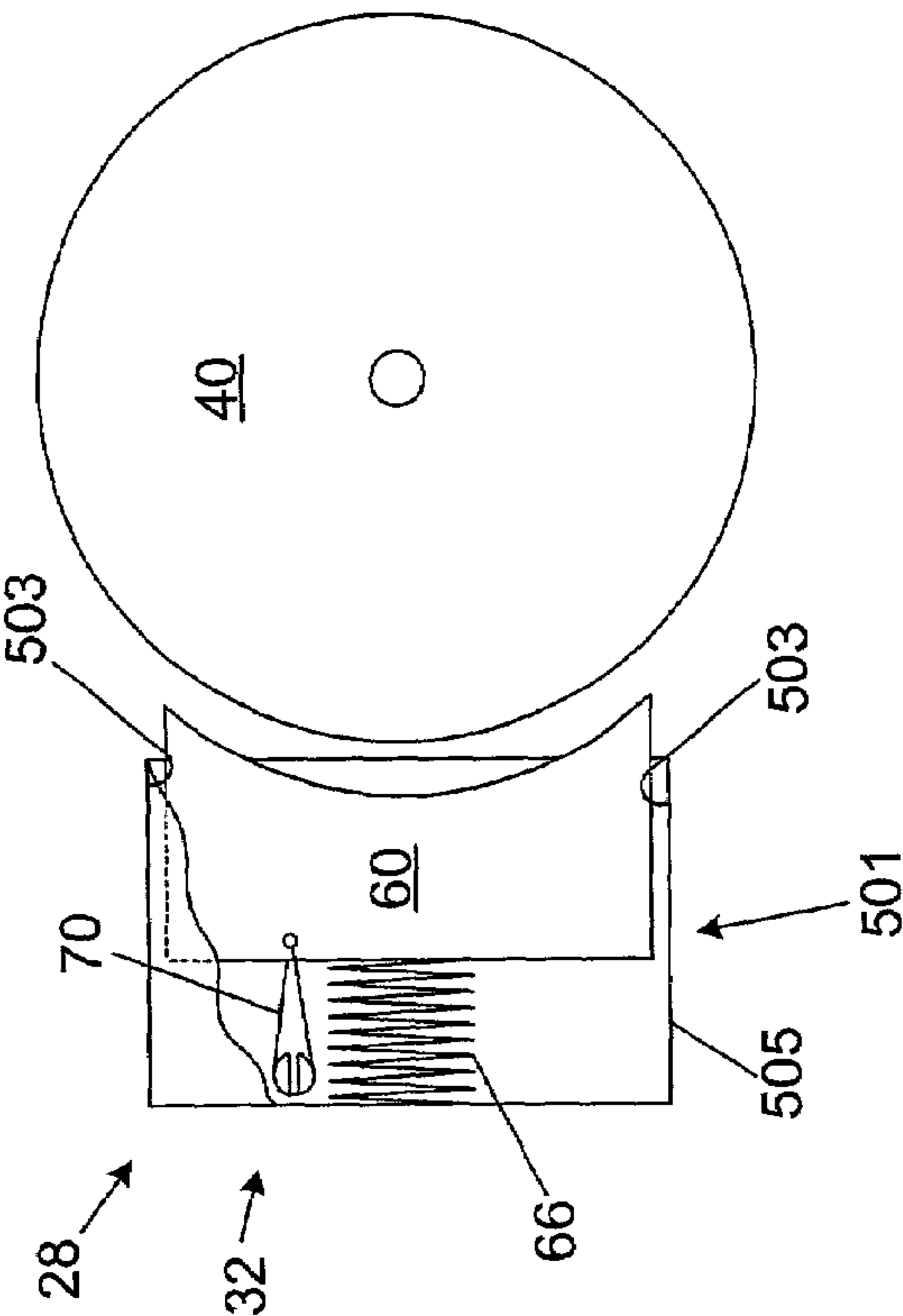


Fig. 23

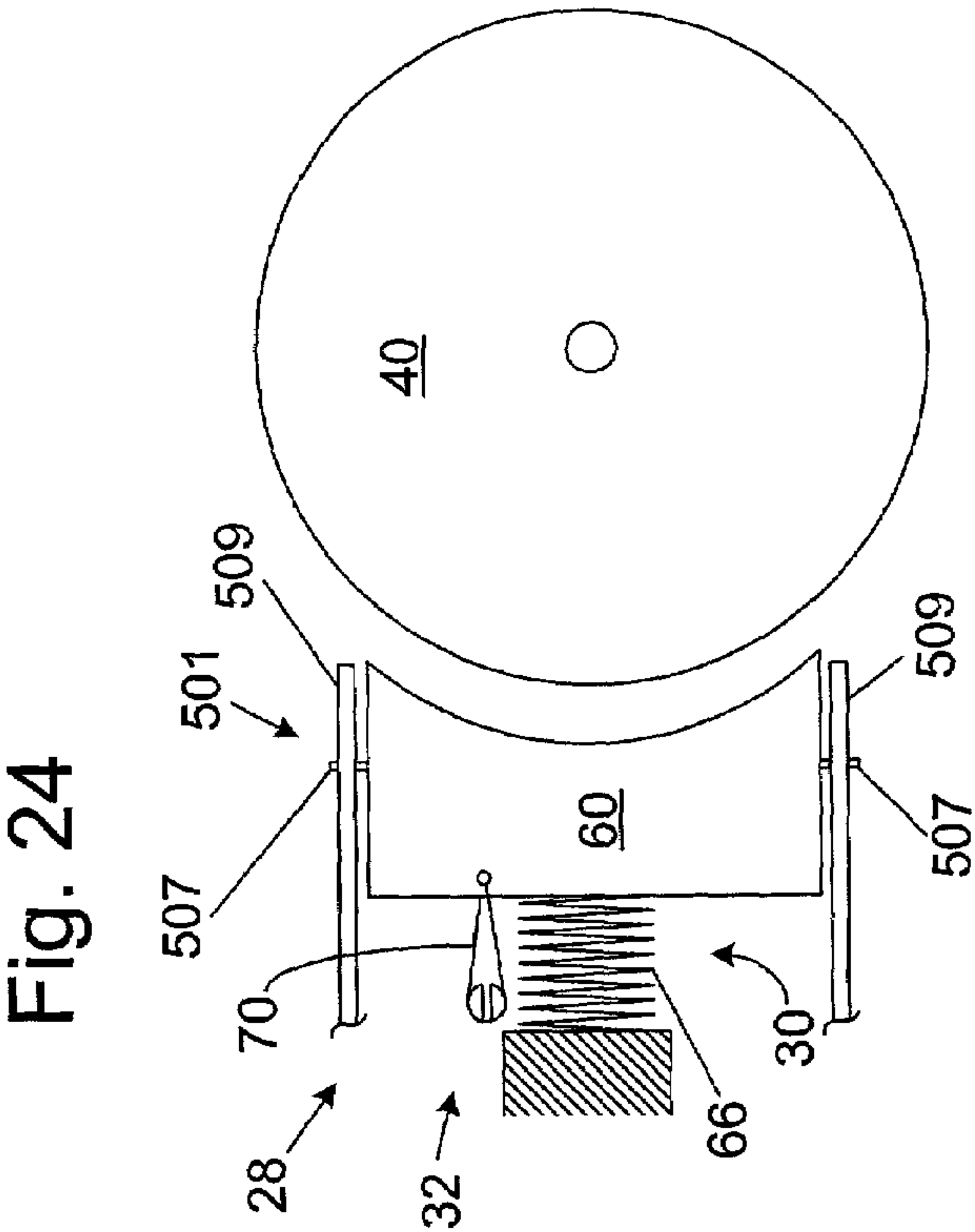


Fig. 24

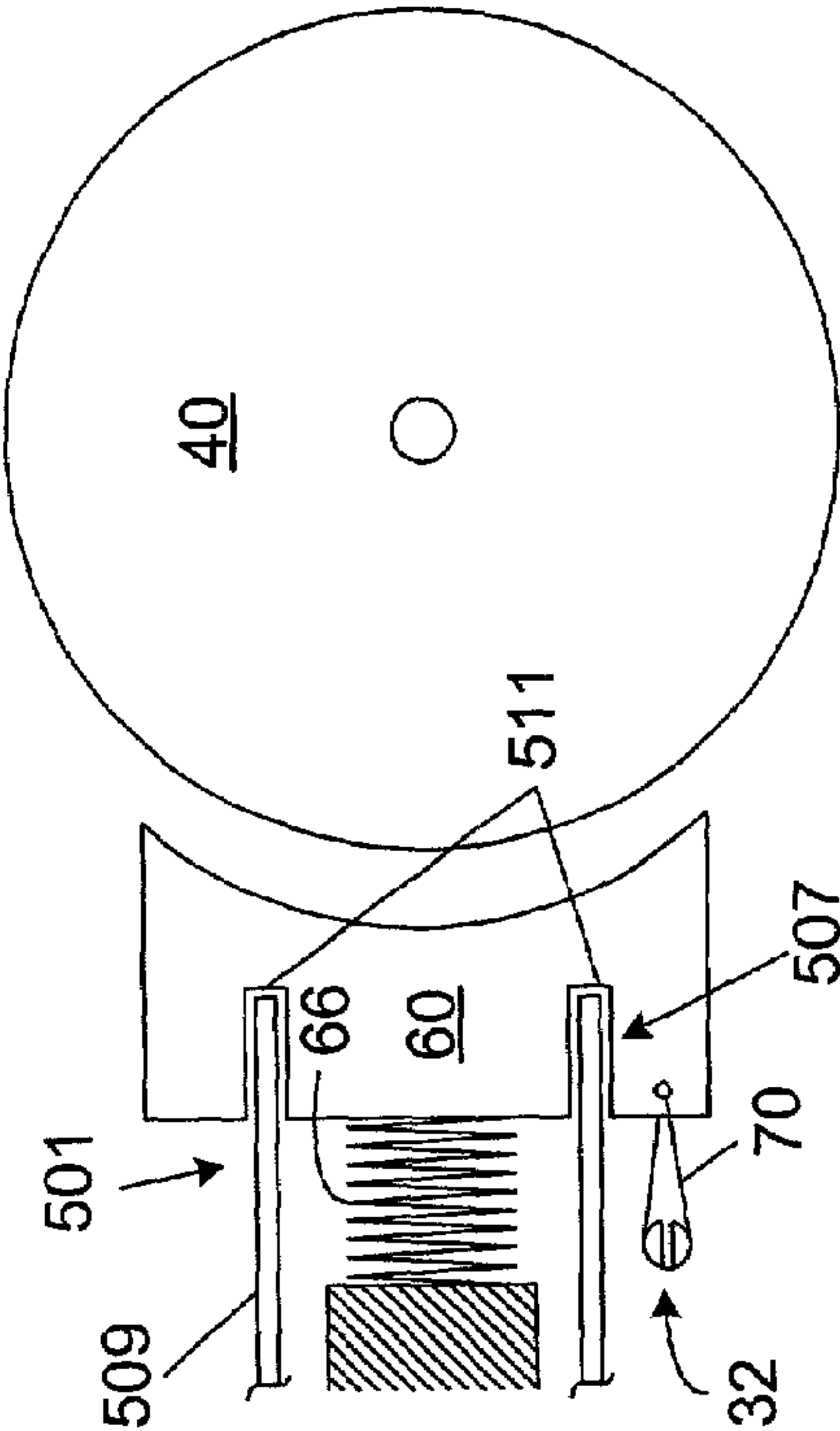


Fig. 25

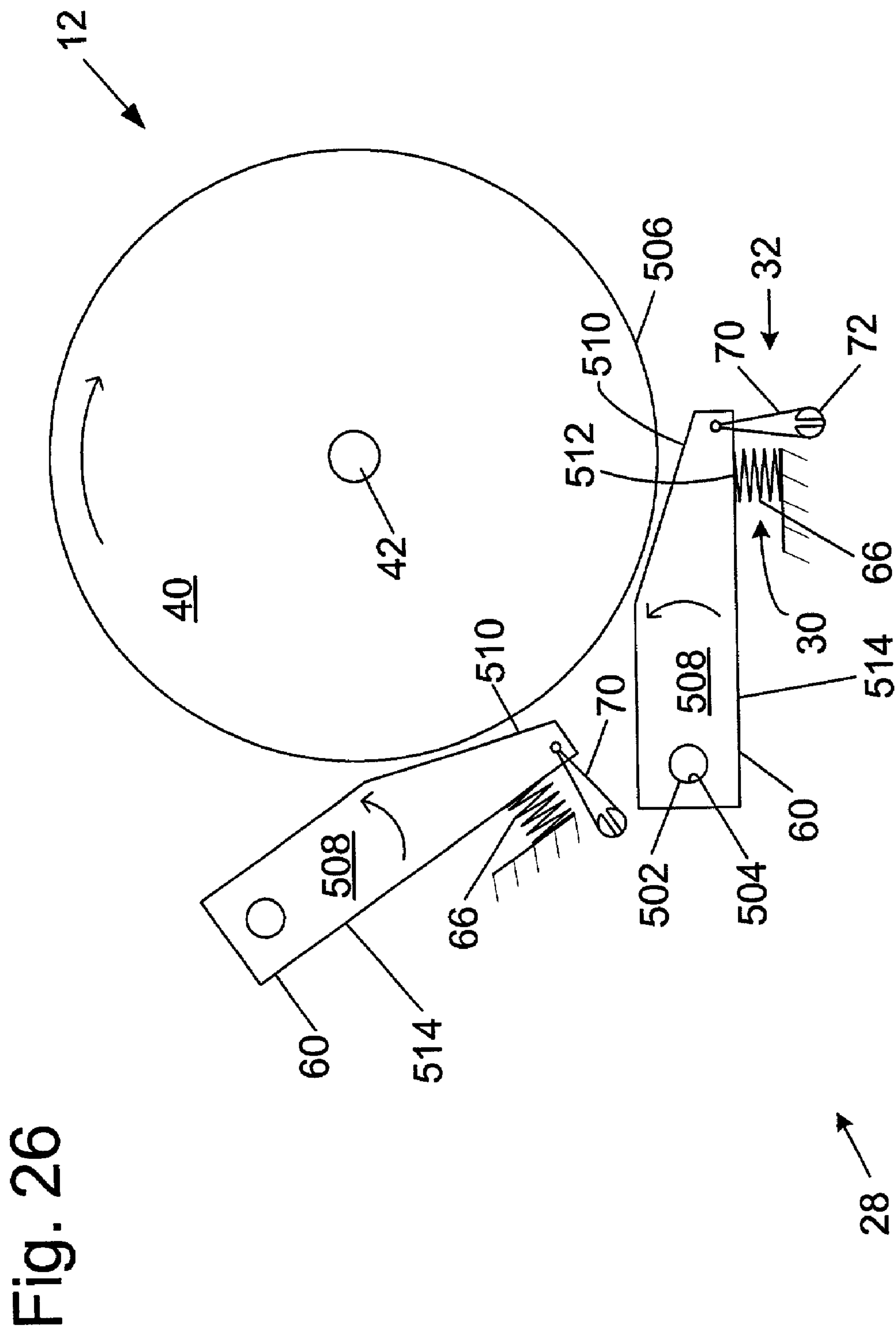
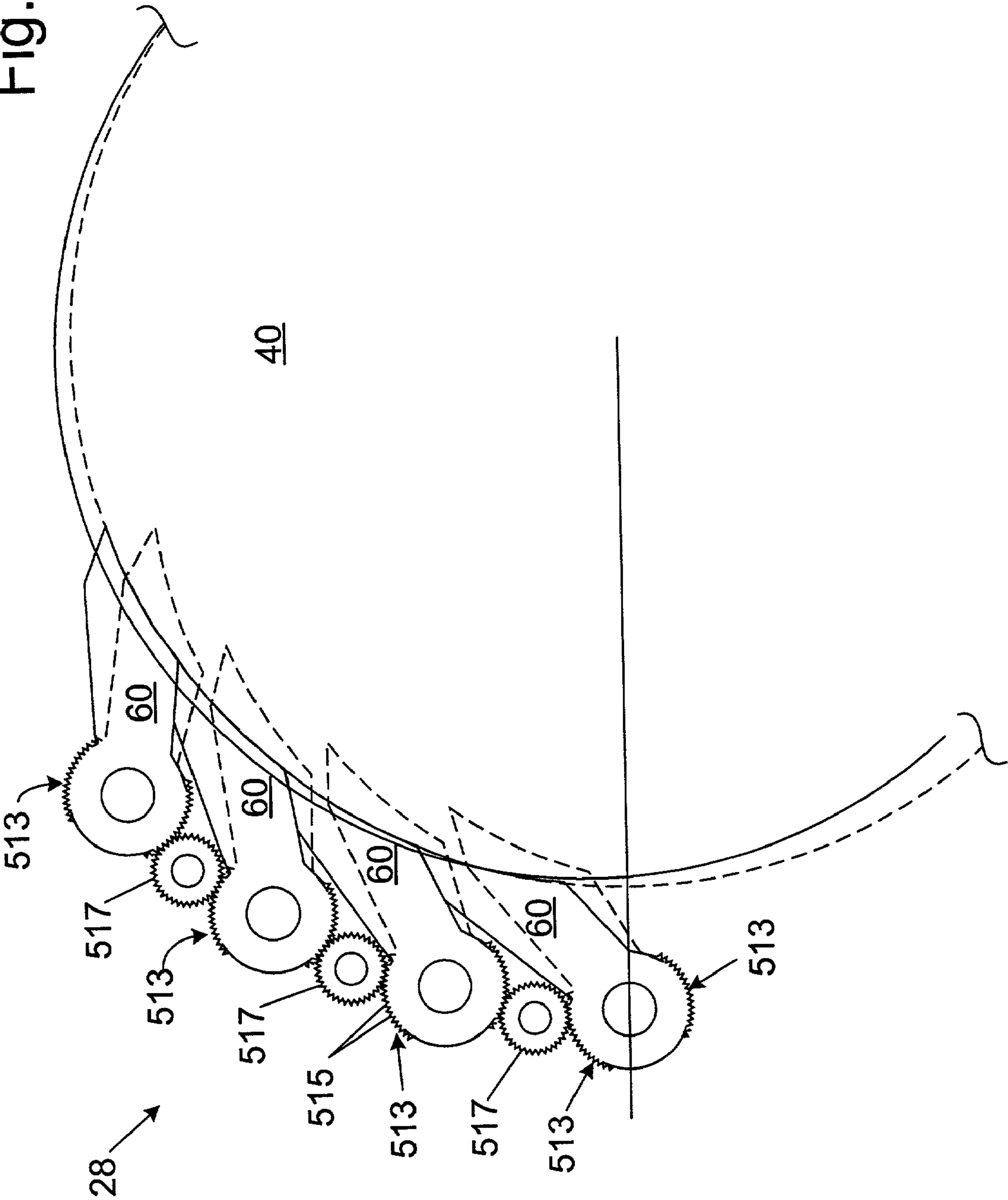




Fig. 27



## 1

**BRAKE MECHANISM FOR POWER EQUIPMENT****CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of and priority from the following U.S. Provisional Patent Applications: Ser. No. 60/225,056, filed Aug. 14, 2000, Ser. No. 60/225,057, filed Aug. 14, 2000, Ser. No. 60/225,058, filed Aug. 14, 2000, Ser. No. 60/225,059, filed Aug. 14, 2000, Ser. No. 60/225,089, filed Aug. 14, 2000, Ser. No. 60/225,094, filed Aug. 14, 2000, Ser. No. 60/225,169, filed Aug. 14, 2000, Ser. No. 60/225,170, filed Aug. 14, 2000, Ser. No. 60/225,200, filed Aug. 14, 2000, Ser. No. 60/225,201, filed Aug. 14, 2000, Ser. No. 60/225,206, filed Aug. 14, 2000, Ser. No. 60/225,210, filed Aug. 14, 2000, Ser. No. 60/225,211, filed Aug. 14, 2000, and Ser. No. 60/225,212, filed Aug. 14, 2000.

**FIELD**

The present invention relates to safety systems for power equipment, and more particularly to a brake mechanism for use on power equipment, such as woodworking machines.

**BACKGROUND**

Safety systems are often employed with power equipment such as table saws, miter saws, band saws, jointers, shapers, circular saws and other woodworking machinery, to minimize the risk of injury when using the equipment. Probably the most common safety feature is a guard that physically blocks an operator from making contact with dangerous components of machinery, such as belts, shafts or blades. In many cases, guards effectively reduce the risk of injury, however, there are many instances where the nature of the operations to be performed precludes using a guard that completely blocks access to hazardous machine parts.

The present invention discloses a safety system, and power equipment incorporating a safety system, that includes a brake mechanism adapted to engage the blade or other cutting tool to protect the user against serious injury if a dangerous, or triggering, condition, such as contact between the user's body and the blade or other cutting tool, occurs. The brake mechanism includes a pawl that is biased to engage and quickly stop the blade or other cutting tool.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is a schematic block diagram of a machine with a fast-acting safety system according to the present invention.

FIG. 2 is a schematic diagram of an exemplary safety system in the context of a machine having a circular blade.

FIG. 3 is a side elevation view of a brake mechanism, including a pawl, according to the present invention.

FIG. 4 is a side elevation view of a portion of another brake mechanism according to the present invention.

FIG. 5 is a side elevation view of another pawl according to the present invention.

FIG. 6 is a side elevation view of another pawl according to the present invention.

FIG. 7 is an isometric view of another pawl according to the present invention.

FIG. 8 is a side elevation view of another pawl according to the present invention.

FIG. 9 is a side elevation view of another pawl according to the present invention.

## 2

FIG. 10 is a side elevation view of another pawl according to the present invention.

FIG. 11 is a side elevation view of another pawl according to the present invention.

FIG. 12 is a side elevation view of another pawl according to the present invention.

FIG. 13 is a side elevation view of another pawl according to the present invention.

FIG. 14 is a side elevation view of another pawl according to the present invention.

FIG. 15 is a side elevation view of another pawl according to the present invention.

FIG. 16 is a side elevation view of another pawl according to the present invention.

FIG. 17 is a side elevation view of another brake mechanism according to the present invention.

FIG. 18 is a side elevation view of another brake mechanism according to the present invention.

FIG. 19 is a side elevation view of another brake mechanism according to the present invention.

FIG. 20 is a side elevation view of another brake mechanism according to the present invention.

FIG. 21 is a top plan view of the brake mechanism of FIG. 20.

FIG. 22 is a side elevation view of a brake mechanism according to the present invention with a translational pawl.

FIG. 23 is a side elevation view of another brake mechanism with a translational pawl according to the present invention.

FIG. 24 is a side elevation view of another brake mechanism with a translational pawl according to the present invention.

FIG. 25 is a side elevation view of another brake mechanism with a translational pawl according to the present invention.

FIG. 26 is a side elevation view of a brake mechanism that includes plural pawls.

FIG. 27 is a fragmentary side elevation view of another brake mechanism that includes plural pawls.

FIG. 28 is a top plan view of another brake mechanism according to the present invention.

**DETAILED DESCRIPTION**

A machine is generally at 10. Machine 10 may be any of a variety of different machines adapted for cutting workpieces, such as wood, including a table saw, miter saw (chop saw), radial arm saw, circular saw, band saw, jointer, planer, etc. Machine 10 includes an operative structure 12 having a cutting tool 14 and a motor assembly 16 adapted to drive the cutting tool. Machine 10 also includes a safety system 18 configured to minimize the potential of a serious injury to a person using machine 10. Safety system 18 is adapted to detect the occurrence of one or more dangerous, or triggering, conditions during use of machine 10. If such a dangerous condition is detected, safety system 18 is adapted to engage operative structure 12 to limit any injury to the user caused by the dangerous condition.

Machine 10 also includes a suitable power source 20 to provide power to operative structure 12 and safety system 18. Power source 20 may be an external power source such as line current, or an internal power source such as a battery. Alternatively, power source 20 may include a combination of both external and internal power sources. Furthermore, power source 20 may include two or more separate power sources, each adapted to power different portions of machine 10.



It will be appreciated that operative structure **12** may take any one of many different forms, depending on the type of machine **10**. For example, operative structure **12** may include a stationary housing configured to support motor assembly **16** in driving engagement with cutting tool **14**. Alternatively, operative structure **12** may include a movable structure configured to carry cutting tool **14** between multiple operating positions. As a further alternative, operative structure **12** may include one or more transport mechanisms adapted to convey a workpiece toward and/or away from cutting tool **14**.

Motor assembly **16** includes one or more motors adapted to drive cutting tool **14**. The motors may be either directly or indirectly coupled to the cutting tool, and may also be adapted to drive workpiece transport mechanisms. Cutting tool **14** typically includes one or more blades or other suitable cutting implements that are adapted to cut or remove portions from the workpieces. The particular form of cutting tool **14** will vary depending upon the various embodiments of machine **10**. For example, in table saws, miter saws, circular saws and radial arm saws, cutting tool **14** will typically include one or more circular rotating blades having a plurality of teeth disposed along the perimetrical edge of the blade. For a jointer or planer, the cutting tool typically includes a plurality of radially spaced-apart blades. For a band saw, the cutting tool includes an elongate, circuitous tooth-edged band.

Safety system **18** includes a detection subsystem **22**, a reaction subsystem **24** and a control subsystem **26**. Control subsystem **26** may be adapted to receive inputs from a variety of sources including detection subsystem **22**, reaction subsystem **24**, operative structure **12** and motor assembly **16**. The control subsystem may also include one or more sensors adapted to monitor selected parameters of machine **10**. In addition, control subsystem **26** typically includes one or more instruments operable by a user to control the machine. The control subsystem is configured to control machine **10** in response to the inputs it receives.

Detection subsystem **22** is configured to detect one or more dangerous, or triggering, conditions during use of machine **10**. For example, the detection subsystem may be configured to detect that a portion of the user's body is dangerously close to, or in contact with, a portion of cutting tool **14**. As another example, the detection subsystem may be configured to detect the rapid movement of a workpiece due to kickback by the cutting tool, as is described in U.S. Provisional Patent Application Ser. No. 60/182,866, the disclosure of which is herein incorporated by reference. In some embodiments, detection subsystem **22** may inform control subsystem **26** of the dangerous condition, which then activates reaction subsystem **24**. In other embodiments, the detection subsystem may be adapted to activate the reaction subsystem directly.

Once activated in response to a dangerous condition, reaction subsystem **24** is configured to engage operative structure **12** quickly to prevent serious injury to the user. It will be appreciated that the particular action to be taken by reaction subsystem **24** will vary depending on the type of machine **10** and/or the dangerous condition that is detected. For example, reaction subsystem **24** may be configured to do one or more of the following: stop the movement of cutting tool **14**, disconnect motor assembly **16** from power source **20**, place a barrier between the cutting tool and the user, or retract the cutting tool from its operating position, etc. The reaction subsystem may be configured to take a combination of steps to protect the user from serious injury. Placement of a barrier between the cutting tool and teeth is described in

more detail in U.S. Provisional Patent Application Ser. No. 60/225,206, entitled "Cutting Tool Safety System," filed Aug. 14, 2000 by SD3, LLC, the disclosure of which is herein incorporated by reference. Retraction of the cutting tool from its operating position is described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,089, entitled "Retraction System For Use In Power Equipment," filed Aug. 14, 2000 by SD3, LLC, the disclosure of which is herein incorporated by reference.

The configuration of reaction subsystem **24** typically will vary depending on which action(s) are taken. In the exemplary embodiment depicted in FIG. 1, reaction subsystem **24** is configured to stop the movement of cutting tool **14** and includes a brake mechanism **28**, a biasing mechanism **30**, a restraining mechanism **32**, and a release mechanism **34**. Brake mechanism **28** is adapted to engage operative structure **12** under the urging of biasing mechanism **30**. During normal operation of machine **10**, restraining mechanism **32** holds the brake mechanism out of engagement with the operative structure. However, upon receipt of an activation signal by reaction subsystem **24**, the brake mechanism is released from the restraining mechanism by release mechanism **34**, whereupon, the brake mechanism quickly engages at least a portion of the operative structure to bring the cutting tool to a stop.

It will be appreciated by those of skill in the art that the exemplary embodiment depicted in FIG. 1 and described above may be implemented in a variety of ways depending on the type and configuration of operative structure **12**. Turning attention to FIG. 2, one example of the many possible implementations of safety system **18** is shown. System **18** is configured to engage an operative structure having a cutting tool in the form of a circular blade **40** mounted on a rotating shaft or arbor **42**. Blade **40** includes a plurality of cutting teeth (not shown) disposed around the outer edge of the blade. As described in more detail below, braking mechanism **28** is adapted to engage the teeth of blade **40** and stop the rotation of the blade. U.S. Provisional Patent Application Ser. No. 60/225,210, entitled "Translation Stop For Use In Power Equipment," filed Aug. 14, 2000 by SD3, LLC, the disclosure of which is herein incorporated by reference, describes other systems for stopping the movement of the cutting tool. U.S. Provisional Patent Application Ser. No. 60/225,058, entitled "Table Saw With Improved Safety System," filed Aug. 14, 2000 by SD3, LLC and U.S. Provisional Patent Application Ser. No. 60/225,057, entitled "Miter Saw With Improved Safety System," filed Aug. 14, 2000 by SD3, LLC, the disclosures of which are herein incorporated by reference, describe safety system **18** in the context of particular types of machines **10**.

In the exemplary implementation, detection subsystem **22** is adapted to detect the dangerous condition of the user coming into contact with blade **40**. The detection subsystem includes a sensor assembly, such as contact detection plates **44** and **46**, capacitively coupled to blade **40** to detect any contact between the user's body and the blade. Typically, the blade, or some larger portion of cutting tool **14** is electrically isolated from the remainder of machine **10**. Alternatively, detection subsystem **22** may include a different sensor assembly configured to detect contact in other ways, such as optically, resistively, etc. In any event, the detection subsystem is adapted to transmit a signal to control subsystem **26** when contact between the user and the blade is detected. Various exemplary embodiments and implementations of detection subsystem **22** are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,200, entitled "Contact Detection System For Power Equipment," filed



Aug. 14, 2000 by SD3, LLC and U.S. Provisional Patent Application Ser. No. 60/225,211, entitled "Apparatus And Method For Detecting Dangerous Conditions In Power Equipment," filed Aug. 14, 2000 by SD3, LLC, the disclosures of which are herein incorporated by reference.

Control subsystem 26 includes one or more instruments 48 that are operable by a user to control the motion of blade 40. Instruments 48 may include start/stop switches, speed controls, direction controls, etc. Control subsystem 26 also includes a logic controller 50 connected to receive the user's inputs via instruments 48. Logic controller 50 is also connected to receive a contact detection signal from detection subsystem 22. Further, the logic controller may be configured to receive inputs from other sources (not shown) such as blade motion sensors, workpiece sensors, etc. In any event, the logic controller is configured to control operative structure 12 in response to the user's inputs through instruments 48. However, upon receipt of a contact detection signal from detection subsystem 22, the logic controller overrides the control inputs from the user and activates reaction subsystem 24 to stop the motion of the blade. Various exemplary embodiments and implementations of control subsystem 26 are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,059, entitled "Logic Control For Fast Acting Safety System," filed Aug. 14, 2000 by SD3, LLC and U.S. Provisional Patent Application Ser. No. 60/225,094, entitled "Motion Detecting System For Use In Safety System For Power Equipment," filed Aug. 14, 2000 by SD3, LLC, the disclosures of which are herein incorporated by reference.

In the exemplary implementation, brake mechanism 28 includes a pawl 60 mounted adjacent the edge of blade 40 and selectively moveable to engage and grip the teeth of the blade. Pawl 60 may be constructed of any suitable material adapted to engage and stop the blade. As one example, the pawl may be constructed of a relatively high strength thermoplastic material such as polycarbonate, ultrahigh molecular weight polyethylene (UHMW) or Acrylonitrile Butadiene Styrene (ABS), etc., or a metal such as aluminum, etc. It will be appreciated that the construction of pawl 60 will vary depending on the configuration of blade 40. In any event, the pawl is urged into the blade by a biasing mechanism in the form of a spring 66. In the illustrative embodiment shown in FIG. 2, pawl 60 is pivoted into the teeth of blade 40. It should be understood that sliding or rotary movement of pawl 60 may also be used. The spring is adapted to urge pawl 60 into the teeth of the blade with sufficient force to grip the blade and quickly bring it to a stop.

The pawl is held away from the edge of the blade by a restraining mechanism in the form of a fusible member 70. The fusible member is constructed of a suitable material adapted to restrain the pawl against the bias of spring 66, and also adapted to melt under a determined electrical current density. Examples of suitable materials for fusible member 70 include NiChrome wire, stainless steel wire, etc. The fusible member is connected between the pawl and a contact mount 72. Preferably, fusible member 70 holds the pawl relatively close to the edge of the blade to reduce the distance the pawl must travel to engage the blade. Positioning the pawl relatively close to the edge of the blade reduces the time required for the pawl to engage and stop the blade. Typically, the pawl is held approximately 1/32-inch to 1/4-inch from the edge of the blade by fusible member 70, however other pawl-to-blade spacings may also be used within the scope of the invention.

Pawl 60 is released from its unactuated, or cocked, position to engage blade 40 by a release mechanism in the form of a firing subsystem 76. The firing subsystem is coupled to contact mount 72, and is configured to melt fusible member 70 by passing a surge of electrical current through the fusible member. Firing subsystem 76 is coupled to logic controller 50 and activated by a signal from the logic controller. When the logic controller receives a contact detection signal from detection subsystem 22, the logic controller sends an activation signal to firing subsystem 76, which melts fusible member 70, thereby releasing the pawl to stop the blade. Various exemplary embodiments and implementations of reaction subsystem 24 are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,056, entitled "Firing Subsystem For Use In Fast Acting Safety System," filed Aug. 14, 2000 by SD3, LLC and U.S. Provisional Patent Application Ser. No. 60/225,170, entitled "Spring-Biased Brake Mechanism for Power Equipment," filed Aug. 14, 2000 by SD3, LLC, the disclosures of which are herein incorporated by reference.

It will be appreciated that activation of the brake mechanism will require the replacement of one or more portions of safety system 18. For example, pawl 60 and fusible member 70 typically must be replaced before the safety system is ready to be used again. Thus, it may be desirable to construct one or more portions of safety system 18 in a cartridge that can be easily replaced. For example, in the exemplary implementation depicted in FIG. 2, safety system 18 includes a replaceable cartridge 80 having a housing 82. Pawl 60, spring 66, fusible member 70 and contact mount 72 are all mounted within housing 82. Alternatively, other portions of safety system 18 may be mounted within the housing. In any event, after the reaction system has been activated, the safety system can be reset by replacing cartridge 80. The portions of safety system 18 not mounted within the cartridge may be replaced separately or reused as appropriate. Various exemplary embodiments and implementations of a safety system using a replaceable cartridge are described in more detail in U.S. Provisional Patent Application Ser. No. 60/225,201, entitled "Replaceable Brake Mechanism For Power Equipment," filed Aug. 14, 2000 by SD3, LLC and U.S. Provisional Patent Application Ser. No. 60/225,212, entitled "Brake Positioning System," filed Aug. 14, 2000 by SD3, LLC, the disclosures of which are herein incorporated by reference.

While one particular implementation of safety system 18 has been described, it will be appreciated that many variations and modifications are possible within the scope of the invention. Many such variations and modifications are described in U.S. Provisional Patent Applications Ser. Nos. 60/182,866 and 60/157,340, the disclosures of which are herein incorporated by reference.

As discussed, safety system 18 includes a brake mechanism 28 that is adapted to stop the cutting tool, thereby preventing or reducing injury to the user. As also discussed previously, brake mechanism 28 may include at least one pawl 60 adapted to engage the cutting tool to stop the rotation thereof. For purposes of the following discussion, cutting tool 14 will be described in the context of a blade 40, such as on a table saw, miter saw, circular saw or the like. It should be understood that blade 40 may include single blades, such as plywood or carbide-tipped blades, or an assembly of several blades, such as a dado blade.

As discussed, pawl 60 may be made of any suitable material that is capable of quickly stopping the blade or other cutting tool within the desired time increment, such as less than 5 milliseconds, and preferably, 3 milliseconds or



less. The above examples of thermoplastic and metallic materials have proven effective, although other materials may be used so long as they are able to stop the blade within the desired time increment. Preferably, the pawl is formed of a material that does not damage the machine, and even more preferably, the pawl is formed of a material that does not damage the cutting tool. The pawl may be formed by any suitable method, such as by cutting sheets of the desired material to size or by molding. Similarly, the pawls may be annealed to increase their strength.

It should be understood that the heavier the pawl, the more force it will take to urge the pawl into contact with the blade or other cutting tool within the selected time increment and the more restraining force that restraining mechanism 32 will need to exert to counteract the biasing mechanism. On the other hand, the pawl must have sufficient mass and strength to withstand the forces exerted upon the pawl by the blade. It should also be understood that the longer it takes for pawl 60 to engage the blade after detection of a dangerous, or triggering, condition by detection subsystem 22, the longer the blade will rotate and potentially cut the user's hand or other body part. Therefore, it is preferred that this time be minimized, such as by decreasing the distance pawl 60 must travel to engage the blade and increasing the speed at which the pawl moves to travel this distance. The speed at which the pawl travels is largely dependent upon the weight of the pawl, the force with which biasing mechanism 30 urges the pawl toward the blade upon release of restraining mechanism 32, and any friction in the mechanism.

There is not a specific pawl size, geometry or weight that is required to be suitable for use to stop the blade or other cutting tool. Instead, the size, geometry and weight may vary, depending upon such factors as the particular type of machine and cutting mechanism with which the pawl is used, the pawl material or combinations of materials, the corresponding structure of biasing mechanism 30 and restraining mechanism 32, etc. As such, the following discussion of materials, sizes and geometries are meant to provide illustrative examples of some suitable materials, geometries and sizes. Similarly, pawls may be formed with any combination of one or more of the subsequently discussed elements, subelements and possible variations, regardless of whether the elements, subelements and possible variations are shown together in the same figure.

The thickness of pawl 60 may vary. Thicknesses in the range of approximately 1/2 inch and approximately 1 inch have proven effective, although thicknesses outside of this range may be used so long as the pawl may reliably stop the blade. When thicker blades, such as dado blades are used, the pawl is more likely to have a thickness greater than 1 inch.

Pawl 60 engages the blade to quickly stop the rotation of the blade. Pawl 60 may engage the blade in several different configurations, such as engaging the side of the blade or the teeth of the blade. As shown in FIG. 3, pawl 60 is pivotally mounted on an axle 502 that extends through a bore 504 in the pawl, and pawl 60 is adapted to pivot into the teeth 506 of blade 40 under the influence of a biasing mechanism, such as spring 66. It is within the scope of the invention that the pivotal pawls described herein may alternatively pivot with an axle upon which the pawl is secured, as opposed to pivoting about the axle. Other suitable biasing mechanisms are disclosed in copending U.S. Provisional Patent Application Ser. No. 60/225,170, entitled "Spring-Biased Brake Mechanism for Power Equipment," filed Aug. 14, 2000 by SD3, LLC, which is incorporated herein by reference. Preferably, pawl 60 is adapted to be self-locking, i.e., drawn into

tighter engagement with the teeth of blade 40 due to the relative geometry of the blade and pawl as they are drawn together. For example, when blade 40 is spinning in the indicated direction in FIG. 3, the blade will draw the pawl into tighter engagement with the blade when the blade contacts the pawl.

The spacing from pawl 60 to blade 40 when the pawl is in its restrained, or cocked, position may vary. For example, this spacing may vary depending on the configuration of the particular cutting tool, the detection system, and/or the brake system. Preferably, this distance is minimized to reduce the time required for the pawl to travel across this distance and engage the blade. It has been found that a space of approximately 1/32-inch to 1/4-inch between the pawl and blade provides suitable results. A spacing of approximately 1/8-inch has proven particularly effective, although larger and smaller distances may be used and are within the scope of the present invention. Because many cutting tools such as saw blades do not have precisely uniform dimensions, it may be necessary to position the pawl sufficiently away from the blade to account for variations or irregularities in a particular blade, such as described in copending U.S. Provisional Patent Application, which is entitled "Brake Positioning System," and which is incorporated herein by reference. Also it may be necessary to adjust the position of the pawl whenever a blade is replaced to account for variations between particular blades. For example, for circular saw blades having nominal diameters of 10-inches and nominal thicknesses of 0.125-inch, actual blades from various manufacturers or for different applications may have diameters that range between 9.5-inches and 10.5-inches and thicknesses that range between 0.075-inch and 0.15-inch.

In the illustrative embodiment of pawl 60 shown in FIG. 3, it can be seen that pawl 60 includes a body 508 with a contact surface 510 that is adapted to engage blade 40. Pawl 60 also includes an engagement member 512 that is adapted to be engaged by biasing mechanism 30. As shown engagement member 512 forms part of the face 514 of the pawl that faces generally away from the cutting tool. Engagement member 512 may also include a recess into or protrusion from the body of the pawl. In the mounting position shown in FIG. 3, pawl 60 pivots into the blade upon release of restraining mechanism 32, such as when the safety system sends a current through fusible member 70. When the pawl contacts the blade, the contact surface extends generally tangential to the blade, and the teeth of the blade embed into the pawl.

Another illustrative example of pawl 60 is shown in FIG. 4. As shown, the pawl is somewhat smaller than the pawl shown in FIG. 3. An advantage of a smaller pawl is that it will be lighter than a larger pawl constructed from the same material, and therefore it will not require as great of spring force to urge the pawl into the blade in a selected time interval as a heavier pawl. On the other hand, a smaller pawl will tend to, but not necessarily, have a smaller contact surface 510. In FIG. 4, the pawl includes a blade-engaging shoulder 516 that is adapted to engage the blade before the contact surface, or at least a substantial portion of the contact surface, engages the blade. Shoulder 514 may include a protrusion 516' that extends from the surface 518 of the pawl generally facing the blade. Shoulder 516 and/or protrusion 516' engage the blade prior to the contact surface of the pawl, and this contact quickly pivots the contact surface of the pawl into engagement with the blade. In essence, the shoulder or protrusion reduces the time and/or spring force required to quickly move the pawl into a position to stop the blade by using the blade momentum, transferred by contact



with the shoulder, to draw the pawl into the blade. Also shown in FIG. 4 is another embodiment of engagement member 512, which as shown includes a collar 520 extending from surface 514 and into which a portion of spring 66 is received. Collar 520 has an inner diameter that is greater than the diameter of the portion of the spring received therein. Collar 520 facilitates the positioning of the spring during assembly, or cocking, of the brake mechanism.

Another illustrative example of a suitable pawl 60 is shown in FIG. 5. As shown, the pawl is somewhat larger than the previously illustrated pawls and includes a contact surface 510 that generally conforms to the outer diameter of the blade. Also shown in FIG. 5 is a mounting assembly 522 for restraining mechanism 32. As shown, mounting assembly 522 includes an aperture 524 through which a portion of the restraining mechanism, such as a portion of fusible member 70, extends. Fusible member 70 may also be described as extending around a portion 526 of the pawl. Other suitable fusible members and restraining mechanisms are disclosed in copending U.S. Provisional Patent Application Ser. No. 60/225,056, entitled "Firing Subsystem for Use in a Fast-Acting Safety System," filed Aug. 14, 2000 by SD3, LLC, which is incorporated herein by reference.

To increase the gripping action of the pawls on the blade, the contact surfaces 510 of the pawls may be coated with a performance-enhancing material 527, such as shown in FIG. 6. An example of a performance-enhancing material is a relatively high-friction material such as rubber or a material that "tangles," or snares, in the teeth of the blade or other cutting tool, such as Kevlar cloth or metal mesh. Alternatively, the pawls may be constructed of a harder material than the blade and have a ridged surface to "bite" into the blade. Alternatively, or additionally, the pawl may be configured with grip structure 529 such as coatings of high-friction material, grooves, notches, holes, protuberances, etc., to further increase the gripping action of the pawls.

Pawl 60 may include one or more removed regions. These regions may take any suitable form, such as depressions that extend partially through the pawl or bores or other apertures that extend completely through the pawl. An example of a pawl showing plural removed regions 528 in the form of depressions 530 is shown in FIG. 7. The removed regions reduce the overall weight of the pawl, thereby decreasing the relative force that biasing mechanism 30 needs to exert on the pawl to move the pawl into contact with the blade within a selected time interval, as compared to a similar pawl of greater weight. Depressions, or recesses, 530 may also improve the grip of the pawl on the teeth of the blade by allowing the teeth to bite more deeply into the pawl.

An example of another embodiment of engagement member 512 is also shown in FIG. 7 in the form of a depression 532 that extends into the body 508 of the pawl and into which a portion of spring 66 extends. Depression 532 may be laterally open, or may include sidewalls 534, such as indicated in dashed lines. Also shown in FIG. 7 is a mount 535 adapted to be coupled to biasing mechanism 30. As shown, mount 535 takes the form of a projection around which a portion of a coil spring (such as spring 66 shown in FIG. 4) extends. It should be understood that mount 535 may be used independent of depression 532 and/or side walls 534. The pawl shown in FIG. 7 also shows another suitable embodiment of a mounting assembly 522 for restraining mechanism 32. As shown, the mounting assembly includes a mount 536 for a linkage 538, which is coupled to a fusible member that is not physically in contact with pawl 60.

The pawl shown in FIG. 7 may also be described as having a body 508 with a blade-engaging portion 540 and at

least one region of reduced thickness compared to the blade-engaging portion. For example, the previously described depressions 530 have a reduced thickness compared to blade-engaging portion 540. The increased thickness of the blade-engaging portion provides additional strength to that portion of the pawl, while the reduced-thickness portions reduce the overall mass of the pawl. Pawl 60 may also be described as including one or more ribs, or supports 542 extending generally between bore 504 and blade engaging portion 540 to strengthen the pawl.

An example of a pawl having plural removed regions 543 in the form of apertures 544 is shown in FIG. 8. Apertures 544 reduce the comparative weight of the pawl compared to a similar pawl that does not include apertures or other removed regions. Apertures 544 also provide regions into which the material forming pawl 60 may deform, or flow, into as the blade or other cutting tool strikes the pawl. Having these deformation regions reduces the stress to the pawl as it engages the blade. It should be understood that the size and positioning of the removed regions 543 discussed herein are for purposes of illustration and that these regions may be positioned in any suitable location on the pawl in a variety of shapes, sizes and configurations.

A variation of the pawl of FIG. 8 is shown in FIG. 9, in which the apertures 544 have been filled with another material 546. It should be understood that some or all of the apertures may be partially or completely filled with material 546. For example, the body of pawl 60 may be formed from one of the previously described materials, with the apertures filled with another of the previously described materials or a material other than those described above. As a particular example, the body of the pawl may be formed from polycarbonate or ABS, with apertures 544 filled with aluminum or another suitable metal.

Another variation of the pawl of FIG. 8 is shown in FIG. 10. In FIG. 10, pawl 60 includes a plurality of apertures 544 through which one or more wires 548 are passed. As shown, a single wire 548 is looped through the apertures and also extends across a portion of contact surface 510. Although illustrated schematically with the number of wires or wire strands shown in FIG. 10, there may preferably be many strands of wire, such as in the range of approximately 20 and approximately 500 strands. It should be understood that a "strand" of wire is meant to refer to a length of wire extending across the pawl, such as transverse to the plane of the blade or other cutting tool, regardless of whether the strand is connected to other strands or formed from the same unitary length of wire as other strands. Alternatively, the wire or wires could be threaded through one or more of the apertures without extending across the contact surface. An example of a suitable material for wire 548 is high tensile strength stainless steel, which is available in a variety of diameters. In experiments, diameters of 0.01 inch have proven effective, but larger or smaller diameter wires 548, as well as wires formed of other materials, may be used and are within the scope of the invention.

Other forms of composite pawls according to the present invention include pawls formed from two or more regions of different materials. An example of such a composite pawl 60 is shown in FIG. 11, in which the body 508 of the pawl includes a region 550 of material that is a different material than the rest of the body and which forms at least a portion of blade-engaging portion 540. It should be understood that the region 550 may have a variety of shapes, including layers of generally uniform thickness, such as shown in solid lines in FIG. 11, or less uniform shapes, such as layer 550' shown in dashed lines in FIG. 11.



## 11

Pawl **60** may also be formed from composites of materials, such as by layers of different materials or by impregnating or embedding a particular material of construction with another material to add or enhance a desired property. For example, a thermoplastic material may include a frame-  
work or dispersion of fibers or other materials. An example of a pawl constructed of such a composite is shown in FIG. **12**, in which the body of the pawl is formed of a core material **552** into which a filler material **554** is added. Filler material **554** may take the form of particulates, fibers, woven  
fibers, pellets and the like.

Pawl **60** may also include a removable blade-engaging portion **540**. This allows the pawl to be recharged for reuse after the pawl is used to stop blade **60** and the blade-engaging portion is damaged by the blade. It should be understood that “removable” means that the blade-engaging portion may be selectively removed and reattached to the rest of the pawl. An example of such a pawl is shown in FIG. **13**, in which the pawl includes body **508** and removable blade-engaging portion **540'**. Portion **540'** may be formed of the same or a different material or combination of materials as body **508**. Blade-engaging portion **540'** may be attached to body **508** by any suitable attachment mechanism **556**, which is only schematically illustrated in FIG. **13**. Examples of suitable attachment mechanisms **556** include interlocking  
portions on the body and blade-engaging portion and/or mechanical linkages coupled between the body and blade-engaging portion.

In FIG. **14**, pawl **60** includes a sheath, or cover, **558** that overlies at least the blade-engaging portion of the pawl. Sheath **558** is formed of a material that enhances the pawl's ability to stop blade **40**, preferably without damaging the blade. For example, sheath **558** may be formed of Kevlar cloth. Similarly, such a material may be embedded into the thermoplastic or other material forming pawl **60**, such as  
schematically illustrated in FIG. **12**. Sheath **558** may extend completely or partially around the pawl, or alternatively may be partially embedded in the pawl, such as shown in FIG. **15**. Furthermore, Kevlar cloth, or pieces thereof may be embedded into the thermoplastic or other material forming the pawl, such as discussed previously with respect to FIG. **12**, regardless of whether this material extends across the blade-engaging portion of the pawl.

A variation of a pawl that includes sheath **558** is shown in FIG. **16**. In FIG. **16**, the body of the pawl defines a frame **560** that includes spaced-apart side walls **562** defining a channel **564** therebetween. Sheath **558** extends across the channel and is positioned to engage and stop the blade as the pawl is urged into the blade.

When pawl **60** is mounted to pivot into engagement with a blade or other cutting tool, the pawl may include more than one pivot axis. An example of such a pawl is shown in FIGS. **17–19**, in which the pawl is mounted on a pair of pivot arms **566**. As shown, pawl **60** has an elongate contact surface **510** that engages a large portion of the blade. Arms **566** may have the same or different lengths, and can be mounted to pivot anchors (not shown) positioned outside or inside the perimeter of the blade. An advantage of a pawl with an elongate contact surface is that the force exerted by the pawl is distributed across a larger portion of the blade, thereby allowing the blade to be stopped more quickly. The longer contact surface can also be used to reduce the chance of damage to the blade because the braking force is spread over more teeth.

In FIG. **17**, arms **566** are mounted to suitable portions of machine **10** distal the blade relative to pawl **60**, while in FIG. **18**, the arms are mounted proximate the blade relative to

## 12

pawl **60**. In FIG. **19**, one of the pivot arms extends distal the blade, while the other extends proximate the blade relative to the pawl. An advantage of pivot arms that extend toward, or proximately, the blade relative to the pawl is that the pawl cannot be pivoted beyond a point after which the pawl will pivot away from the blade rather than toward the blade. In the embodiment of pawl **60** shown in FIG. **18**, for example, the pawl will always be drawn into tighter engagement with the blade when the blade is rotating in the direction shown and strikes the pawl.

It should be understood that the previously described axle **502** or other structure to which the pawls are mounted may be fixed relative to the housing of the machine. In embodiments of the machine in which the position of the blade is adjustable, the pawl is preferably mounted to move with the blade as the blade's position is adjusted. This latter arrangement ensures that the pawl is maintained in a predetermined position relative to the blade. Similarly, the charging plates are preferably mounted to move with either the blade or arbor to maintain a predetermined and constant spacing thereto.

Alternatively, the pawl may be mounted on a portion of the machine that does not adjust with the blade, but in a mounting orientation suitable for use with the blade regardless of the blade's mounting position. An illustrative example of such a “stationary” pawl is shown in FIGS. **20** and **21**. By “stationary,” it is meant that the position of the pawl does not move with the blade as the relative position of the blade is moved. However, upon actuation of the reaction subsystem, pawl **60** will still move into engagement with the blade. Alternatively, with machines in which the blade may raise and lower as well as tilt, the pawl may be adapted to move with one adjustment, such as tilting with the blade, but remain fixed with the other, such as when the blade is raised or lowered.

As shown in FIGS. **20** and **21**, pawl **60** is elongate and sized and shaped to extend along the outer perimeter **568** of blade **40** as the blade is adjusted vertically. Similarly the width of pawl **60** is sized to extend the breadth of the incline of blade **40**. As shown in FIGS. **20** and **21**, pawl **60** is mounted generally parallel with the vertical axis of travel of the blade, and generally normal to the axis of incline of the blade. As a result, the spacing between the blade and contact surface **510** remains constant regardless of the position or orientation of the blade.

The upper end portion of pawl **60** is pivotally attached to upper pivot arms **570** by pivot pins **572** that pass through one end of arms **570** into the sides of the pawl. The other ends of pivot arms **570** are pivotally attached to one or more mounts (not shown), by pivot pins **574**. The lower end portion of pawl **60** is pivotally attached to lower pivot arms **576** by pivot pins **578** that pass through one end of arms **576** into the sides of the pawl. The lower pivot arms are pivotally attached to mounts (not shown) by pivot pins **580**. Biasing mechanism **30**, such as one or more springs **66**, is attached to the lower pivot arms on the side of pivot pins **580** opposite pivot pins **578**. Thus, pawl **60** is configured to pivot toward or away from blade **40**. Upon release of restraining mechanism **32**, such as fusible member **70**, the biasing mechanism urges the upper ends of pivot arms **576** downward, thereby drawing the lower end of the pivot arms and the corresponding end portion of pawl **60** into engagement with the blade.

Pivot arms **570** and **576** are sized and arranged such that pawl **60** cannot pivot up past the blade without striking the edge of the blade. When the pawl strikes the blade while the blade is rotating, the movement of the blade causes the pawl to continue pivoting upward until the pawl is firmly wedged



between the blade and pivot arms, thereby stopping the blade. The contact surface **510** of the pawl may be textured, coated, etc., to enhance the gripping action between the pawl and the blade.

Pawl **60** is biased upward to pivot toward the blade by biasing mechanism **30**, which for example includes one or more springs **66** that are anchored to the saw frame or other suitable mounting structure. Thus, when the pawl is free to pivot, springs **66** drive the pawl quickly toward the blade. Fusible member **70** is connected to one or both of lower pivot arms **576** to hold the pawl away from the blade. The fusible member is sized to hold the pawl spaced slightly away from the edge of the blade. However, when a sufficient current is passed through the fusible member the fusible member will melt, causing the pawl to pivot toward the blade under the urging of biasing mechanism **30**.

It will be appreciated that many variations to the exemplary embodiment depicted in FIGS. **20** and **21** are possible within the scope of the invention. For example, the pawl may be configured to pivot toward the blade solely due to gravity. Alternatively, springs **66** may be compression springs which normally hold the pawl away from the blade until it is pivoted upward under the force of another spring, an explosive charge, a solenoid, gas pressure, etc. Further, the pawl may be mounted on the other side of the blade to pivot downward into the blade under the force of a spring, an explosive charge, a solenoid, gas pressure, etc.

Another example of a suitable pawl **60** is shown in FIG. **22**. As shown, pawl **60** includes a rearward portion **582** facing generally away from contact surface **510**. Portion **582** includes a plurality of race portions **584** that in cooperation with a corresponding plurality of race portions **586** on a suitable mounting structure **588** forming part of machine **10**, define races **590** within which rollers **592** are housed. Toothed rollers **592** are rotatable within races **590** and direct the translational movement of pawl **60** toward blade **40** when the blade strikes pawl **60**. The rollers also reduce the friction of moving the pawl under braking load relative to a sliding surface. Preferably, pawl **60** includes guide pins **593** that travel within tracks (not shown), which define the range of translational positions of pawl **60** while maintaining the rollers in contact with the races.

In FIG. **23**, another illustrative embodiment of a brake mechanism **28** that includes a pawl **60** that moves via translation into engagement with the blade or other cutting tool is shown. Pawl **60** includes a contact surface that preferably, but does not necessarily, conform to the outer diameter of blade **40**. Pawl **60** is retained in its cocked, or restrained, position by restraining mechanism **32**, which as shown, includes one or more fusible members **70**. Preferably, braking mechanism **28** includes guide structure **501** that defines a track **503** along which the pawl travels as it is urged toward the blade or other cutting tool by biasing mechanism **30**. An example of such a guide structure is shown in FIG. **23**, in which the guide structure includes a housing **505** into which the pawl is at least partially received in its cocked, or restrained position, and from which the pawl at least partially projects upon release of restraining mechanism **32**. Much like a piston moving within a cylinder, pawl **60** travels in a translational path defined by the inner dimensions of housing **505** under the urging of biasing mechanism **30**.

Other illustrative examples of brake mechanisms **28** with translational pawls are shown in FIGS. **24** and **25**. In FIG. **24**, guide structure **501** includes two or more guide-engaging members **507** that project from pawl **60** to engage a corresponding number of guides **509**. Guides **509** are spaced

apart from the pawl and define the translational path of the pawl. In FIG. **25**, pawl **60** includes internal guide-engaging members **507**, such as one or more internal bores **511** extending parallel to the translational path of the pawl. A corresponding number of guides **509** extend at least partially within the bores to define the travel path of the pawl. In FIGS. **23–25**, pawls **60** are urged along a translational path directly into blade **40**. It should be understood that the pawls and/or the guide structure may be inclined at an angle relative to the blade, such as to counteract the angular momentum of the blade or to utilize the braking force to draw the pawl more tightly against the blade.

Although the exemplary embodiments are described above in the context of a single brake pawl that engages the teeth of a blade, the brake system may incorporate a brake mechanism with two or more pawls that engage two or more locations on the perimeter of the blade to decrease the stopping time and/or spread the stopping forces. An example of such a brake mechanism is shown in FIG. **26**, in which the brake mechanism includes two spaced-apart pawls **60** adapted to engage the perimeter of blade **40**. Pawls **60** are only schematically illustrated in FIG. **26** and could include any of the previously described pawl or pawls incorporating one or more of the features, elements, subelements and variations described above. The pawls may be released from their to cocked, or restrained, positions by a common release mechanism, or each pawl may have its own release mechanism. When brake mechanism **28** includes plural pawls, it may be desirable to position the pawls on opposite sides of the arbor about which the blade rotates to reduce the load on the arbor when the brake mechanism is actuated and the pawls engage the blade.

When brake mechanism **28** includes plural pawls, the pawls may also be constrained or interconnected to act together. An example of such a brake mechanism is shown in FIG. **27**, in which the brake mechanism includes a plurality of interconnected pawls **60**. As shown, each pawl **60** includes one or more toothed regions **513** having a plurality of teeth **515**. Regions **513** of adjacent pawls **60** are interconnected by toothed gears, or linkages, **517** that communicate the rotation of one pawl to the other pawls so that the pawls move as a unit. It should be understood that one or more of the pawls or gears are coupled to a suitable biasing mechanism and restraining mechanism to bias the pawls into contact with blade **40** and to selectively restrain the movement of the pawls until the reaction subsystem is actuated. In a variation of the brake mechanism shown in FIG. **27**, gears **517** may be omitted, in favor of links interconnecting the pawls.

As discussed, the pawl or pawls of brake mechanism **28** may contact any suitable portion of blade **40** or other cutting tool **14**. In the illustrative embodiments shown in FIGS. **2–27**, the pawls were mounted to engage the teeth or outer perimeter of the blade. An example of another suitable contact portion of the blade is the side of the blade. Specifically, brake mechanism **28** may include two or more pawls adapted to engage opposed sides of the blade. An example of such a brake mechanism is illustrated in FIG. **28**. As shown, pawls **60** are pivotally mounted on either side of blade **40**. Each pawl includes a blade-engaging portion **540** adjacent the blade, and a distal portion **519**. The pawls are pivotally mounted on pins **521** that pass through pivot apertures **523** in the pawls intermediate the blade-engaging portion and the distal portion. Lever arms **525** are coupled to distal portions **519**. Thus, when the lever arms of each pawl are pivoted upward (as viewed in FIG. **28**), the blade-engaging portions close together. The pawls are



15

mounted relative to the blade so that the contact surfaces pivot toward the blade in the direction of blade travel. Once the pawls contact and grip the blade, they continue to pivot inward pulled by the downward motion (as viewed in FIG. 28) of the blade. As a result, the blade is pinched more and more tightly between the contact surfaces 510 of the pawls until the pawls can close no further, at which point the blade is stopped between the pawls.

To ensure that both pawls close together on the blade, a linkage 527 is attached, at one end, to lever arms 525. Linkage 527 is coupled to a biasing mechanism, not shown, which urges the pawls into contact with the blade, through force exerted through linkage 527 and lever arms 525.

It will be appreciated that the dual-pawl system described above may be implemented with many variations within the scope of the invention. For example, the linkage may be driven upward by any of the other actuating means described above, including an explosive charge, solenoid, compressed gas, etc. As another example, one or more pawls may be positioned to contact only one side of the blade. Additionally, the linkage may be omitted, and each pawl actuated by a separate spring, explosive charge, solenoid, etc. Similarly, although a circular blade 40 was used to illustrate one type of cutting tool for which the brake system may be used, it may also be used with other shapes of blades, such as blades used in jointers, shapers and band saws.

It is believed that the disclosure set forth above encompasses multiple distinct inventions with independent utility. While each of these inventions has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense as numerous variations are possible. The subject matter of the inventions includes all novel and non-obvious combinations and subcombinations of the various elements, features, functions and/or properties disclosed herein. No single feature, function, element or property of the disclosed embodiments is essential to all of the disclosed inventions. Similarly, where the claims recite "a" or "a first" element or the equivalent thereof, such claims should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

It is believed that the following claims particularly point out certain combinations and subcombinations that are directed to one of the disclosed inventions and are novel and non-obvious. Inventions embodied in other combinations and subcombinations of features, functions, elements and/or properties may be claimed through amendment of the present claims or presentation of new claims in this or a related application. Such amended or new claims, whether they are directed to a different invention or directed to the same invention, whether different, broader, narrower or equal in scope to the original claims, are also regarded as included within the subject matter of the inventions of the present disclosure.

What is claimed is:

1. A woodworking machine comprising:

a rotatable blade having one or more teeth;

a detection system associated with the blade and configured to detect one or more dangerous conditions; and

a brake mechanism configured to stop the rotation of the blade if one of the dangerous conditions is detected, where the brake mechanism includes at least one brake pawl configured to pivot into the teeth of the blade.

2. The machine of claim 1, where the brake pawl is plastic.

16

3. The machine of claim 2, where the brake pawl is metal.

4. The machine of claim 1, where the brake pawl is aluminum.

5. The machine of claim 1, further comprising a spring configured to urge the brake pawl into the teeth of the blade, and where the brake pawl includes at least one engagement member adapted to be engaged by the spring to position the spring relative to the brake pawl.

6. The machine of claim 5, further comprising a restraining mechanism configured to releasably hold the brake pawl spaced-apart from the blade against the urging of the spring, and where the brake pawl includes a mounting structure for connecting the restraining mechanism to the brake pawl.

7. The machine of claim 6, where the mounting structure is spaced-apart from the engagement member.

8. The brake system of claim 1, wherein the brake pawl is self locking against the blade upon contact with the teeth.

9. A woodworking machine comprising:

a cutting tool having one or more teeth;

a motor configured to drive the cutting tool;

a detection system adapted to detect one or more dangerous conditions between a person and the cutting tool; and

a brake mechanism including a brake pawl movable into contact with the cutting tool so that a tooth-engaging portion of the brake pawl binds against the teeth of the cutting tool to stop movement of the cutting tool when the detection system detects at least one of the dangerous conditions;

where the tooth-engaging portion of the brake pawl is formed of metal.

10. The machine of claim 9, where the one or more teeth are formed of a material having a lesser hardness than the tooth-engaging portion so that the tooth-engaging portion bites into the teeth.

11. The machine of claim 9, where the tooth-engaging portion is formed of aluminum.

12. The machine of claim 11, where the one or more teeth are formed of a material having a greater hardness than aluminum so that the teeth bite into the tooth-engaging portion when the tooth-engaging portion binds against the teeth.

13. A woodworking machine, comprising:

a movable cutting tool for cutting workpieces;

at least one motor configured to drive the cutting tool;

a detection system configured to detect one or more dangerous conditions between a person and the cutting tool; and

a brake mechanism configured to stop movement of the cutting tool upon detection of one of the dangerous conditions by the detection system;

where the brake mechanism includes one or more metal braking components configured to move into contact with, and bind against, the cutting tool to stop movement of the cutting tool, and where the braking components include one or more ridges adapted to at least partially bite into the cutting tool.

14. A woodworking machine, comprising:

a movable cutting tool having one or more teeth;

a motor configured to drive the cutting tool;

a detection system configured to detect one or more dangerous conditions between a person and the cutting tool; and

a brake mechanism including at least one brake pawl configured to engage the cutting tool upon detection of one of the dangerous conditions by the detection sys-

17

tem, and to pivot tightly into, and bind against, the teeth to stop the movement of the cutting tool.

15. The machine of claim 14, where the brake pawl is configured to be pulled into binding engagement with the cutting tool by the teeth of the cutting tool.

16. A woodworking machine comprising:  
a rotatable blade having one or more teeth;  
a detection system associated with the blade and configured to detect one or more dangerous conditions; and  
brake means for stopping the rotation of the blade if one of the dangerous conditions is detected, where the brake means includes brake pawl means for pivoting into the teeth of the blade.

18

17. A woodworking machine comprising:  
a rotatable blade having one or more teeth, where the blade is generally planar;  
a detection system associated with the blade and configured to detect one or more dangerous conditions; and  
a brake mechanism configured to stop the rotation of the blade if one of the dangerous conditions is detected, where the brake mechanism includes at least one brake pawl configured to pivot into the teeth of the blade around an axis generally perpendicular to the plane of the blade.

\* \* \* \* \*



UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 7,024,975 B2  
DATED : April 11, 2006  
INVENTOR(S) : Stephen F. Gass et al.

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 16.

Line 1, change "The machine of claim 2," to -- The machine of claim 1, --.

Signed and Sealed this

Thirteenth Day of June, 2006

A handwritten signature in black ink, reading "Jon W. Dudas", is written over a rectangular area with a light gray dotted background.

JON W. DUDAS

*Director of the United States Patent and Trademark Office*